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THE MILKWEEDS.

BY JOSEPH F. JAMES, M.S.[1]

WHO is there that has not noticed the sticky, whitish juice which exudes on the breaking of the stem of the large and common Milkweed growing so plentifully in waste places and along roadsides? Who has not also noticed that neither horses nor cattle ever touch the plant? While the herbage all around will be closely cropped, often not a blade of grass left more than half an inch high, the Milkweed rears its head aloft in conscious pride of vantage. It well knows, apparently, that it is not acceptable to the animals grazing about it, and finds itself left to perfect its seed in peace and at leisure. It has, perhaps, seemed strange to observe that the plant is so little molested by cattle. It is, to be sure, rank and robust; but that is not a sufficient reason for being rejected. The great Horseweed grows higher and ranker, but is greedily eaten by horses; and many weeds, apparently as little palatable, are devoured. What is there about the Milkweed which gives it an advantage over the other plants of the field? In this, as in other cases, the common name tells the story; but it does not tell why the milky juice, from which it has received its name, is so abundant.

In spite of the platitudes about the peacefulness of nature, as contrasted with the warfare of mankind, no one can wander through woods and fields without coming, in a short time, to

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the conclusion that the warfare there is even more severe than it is with the human race. He will find that carnivorous animals devour others weaker than themselves; birds feed on grasshoppers and other insects; these again prey on others; and so the warfare continues down to the minute animalcule which can be seen only under the microscope, and which swallows other creatures only a little smaller than itself. Not only so, but he will find the Carnivora disputing with their own kind; wolves fighting with other wolves; birds contending with other birds for the insects they need; and these in their turn fighting their own kind for nearly every mouthful of food. Everywhere he will find war being waged continually; so that he must finally come to the conclusion that nature is far sterner than man in the struggle for the means of living.

Perhaps he may think that in the animal world alone this warfare is going on; but if he turns to the vegetable kingdom with the idea that here there can be no such struggle, a short time will convince him of his mistake. He will not, indeed, as a rule, see one plant devouring another in a literal sense; but he will find one sort of tree crowding and pushing another, or overshadowing smaller plants so that they cannot live; he will see them in the fields so close together that he soon concludes they must take more or less moisture and nutriment from each other; he will find the roots so crowded and matted together that the soil is a mass of them; that here one plant has fastened itself on another and is sucking its life away; and he will be forced at last to give a reluctant assent to the assertion that there is warfare among plants as there is among animals, and that the difference is one not of kind, but of degree. This constant, continual, fierce fight is the struggle for existence, in the course of which the fittest will survive. In other words, that plant or animal will be the most likely to live and continue to propagate its species which can best succeed in crowding out some of its competitors, and in taking the nourishment they need to itself.

It is for the purpose of carrying on this continual struggle that many structures have become developed. For instance, the lion has had his strength increased and his retractile claws sharpened by the constant effort he is obliged to make to conquer and carry off his prey. There can be no doubt but that

these claws have been acquired in the course of ages, being developed more and more fully as time went on. Neither can there be any doubt but that they are now necessary for his existence. So it is with all other weapons of defence or offence that have been developed by use. Their principal purpose has been to enable their possessor to live, and, as the strongest and the one best provided with good weapons is the one most likely to continue his kind, improvement goes on until a certain degree of perfection is attained, and the animal is fitted to a place which it holds against all competitors.

While adaptations of one kind arise among animals to enable them to compete with each other in this struggle, adaptations of another kind are developed in the plant world. These take the form of hairs on the stems and leaves; stronger modes of growth; climbing propensities; parasitic habits; the development of prickles or thorns; the formation of deleterious juices, unpleasant odors, or aromatic qualities. Others, again, place their chief reliance for continuing their species on the hard shell encasing their nuts or fruits, and, by producing these in enormous numbers, have an excellent chance of perpetuating themselves. All these have, it should be understood, been acquired by plants so they can hold their ground in the battle for life; and, consequently, those species best provided with means to resist the attacks of animals, either by being more unpalatable through disagreeable odors or tastes, or by having tougher or harder shells to the seeds, or by being aromatic, or in some other way, will stand the best chance of living long enough to perfect seed, and thus be the means of continuing their kind.

Each one of the many ways of resisting the attacks of animals has been only gradually acquired. From a small beginning, the importance of which is not at first to be perceived, the features have increased in usefulness and attained perfection only after many severely fought battles with hardy antagonists.

Perhaps one of the most effectual of all the modes of protection acquired by plants is to be found in the presence of a milky or colored juice. This is a character which is shared in common by a great number of species of widely different orders; but there is no species in which the milky juice is more conspicuous than in the Milkweed. While in various species of the Compositæ, such as the Dandelion, the Wild Lettuce, and the

Sow-Thistle, this juice is plainly seen; while in the Buttercup it is acrid, and in the Blood-root it is red, yet in none of these does it seem to serve the purpose so well as in the Milkweeds. It is not, either, confined to any one species, but is characteristic of most members of the order. The species number over thirteen hundred, are widely scattered over the world, and are most diversified in form and habit. Some of them are climbers, some creepers, some herbs of upright growth, some shrubs, and some trees. Two features which are found in many of them are the milky juice and the peculiar flowers. In the common Milkweed of this country (*Asclepias cornuti*) these peculiarities are seen better than in almost any other species. It is also well known that the plant will thrive in nearly every sort of situation; consequently it must possess some quality that gives it a better chance to grow than many other plants. The reason for its dominance is no other than the possession of its sticky, milky juice.

The sap of plants, though varying in different species, serves the same purpose in all. While primarily it is useful in one way, secondarily it may be beneficial in another; yet, not every plant possesses a sap of such service as that of the Milkweed. Serving as a vehicle for the conveyance of nourishment from the roots to the leaves, it carries with it at the same time such disagreeable properties that it becomes a better protection to the plant from enemies than all the thorns, prickles, or hairs that could be provided. In this plant, so copious and so distasteful has the sap become that it serves a most important purpose in its economy. The gradual development of this feature to its present state has been attended by certain changes in the flowers and fruit, which, together, make the family one of great interest; and when it is known that there are a great many plants which possess a milky sap, only not so well developed as in the Milkweeds, it is only necessary to carry the imagination back to a progenitor which possessed the slightest traces of this, and there is sufficient reason to look for its future perfection. In the fierce struggle which goes on constantly among plants, anything which is advantageous in the slightest degree is sure to be preserved; and as it is transmitted to the progeny, and by them sent on downwards, it will improve at every step. If, for example, the plant becomes disagreeable to the animal grazing in its vicinity,

it will be left alone just as long as there is anything else to be found. Should there come a favorable season, with an abundant vegetation and good grazing, such plants will then have an excellent chance of perfecting seed. Even during a season when plant-life must struggle for water, and when herbivorous animals greedily devour everything they can find, the milky-juiced plant will succeed better than any other, because it will be the last one to be touched. Thus from generation to generation the development will go on, until it reaches a state which requires no further change, and it then remains quiescent. Having, however, once acquired a feature, it will be a long time, indeed, before it will lose it. In the present instance the flowers seem to have been developing in their way, while the juice pursued its own.

The flowers of the common species are produced in large clusters, are pink in color, and have quite a perceptible odor. They are visited by insects in great numbers, as many as thirty-one different species having been counted; and this fact shows they possess considerable attractive qualities. If we examine an individual flower of a cluster, a peculiarly complicated mechanism will be revealed. The two floral envelopes, calyx and corolla, are folded back or reflexed on the stem. Inside of these is a column made up of five sac-like bodies, each crowned by a horn-like process. These seem to be nectaries, where honey is secreted. Between the nectaries there is found, on examination, a peculiar slit, wider below than above. At the upper end is a hard, thin lamina, or blade, with the sides bent inwards so that the edges are close together. In swollen sacs

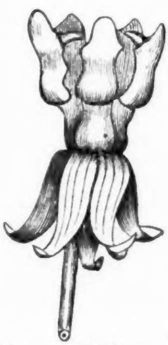


FIG. 1.—Flower of *Asclepias* enlarged.

FIG. 2.—Sac in which the pollinium is lodged.

FIG. 3.—Hood, with horn.

on each side of the slit the pollen-grains are found. The peculiar feature of these grains is that they are united into masses

FIG. 4.—Pollen-masses of *Asclepias* hanging by twisted appendages and fastened to the gland above.

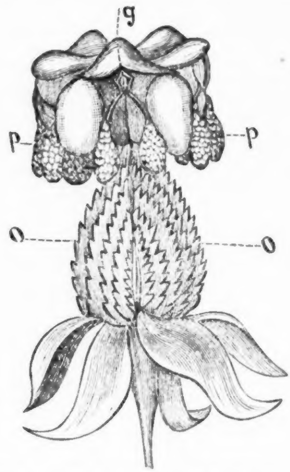


FIG. 5.—Flower with hoods cut away, showing ovaries (*o*), the pollinia (*p*), and the slit or gland (*g*) uniting two of the pollinia.

or clusters, the individual grains held together by sticky threads, —a feature found in only one other family. The stigma surmounts the two ovaries like a large cap, and is placed immediately in the centre of the column, with the pollen-sacs arranged around the outside. To enable the pollen to reach the stigma the pollinium must be taken out of the sac where it hangs and be inserted into the slit between the nectaries. This can only be effected through the agency of insects, and these perform the service in the following manner:

The visitor, attracted by the odor, alights to suck the nectar secreted in the hoods. In its progress over the blossom some one of the hairs of its legs is sure to slide into the slit between the hoods. Pursuing his way by drawing up his leg, the hair will be guided by two flanges at the sides into the upper and narrower part of the slit, and there become fast. Feeling a detention, the captive will pull to release himself, and, if possessed of sufficient force, will bring out of the sacs at the sides two pear-shaped pollinia, each fastened to the lamina, or gland, by a short appendage (see figure). When they are first withdrawn the pollinia are divergent. In a comparatively short space of time the appendages begin to twist, and then the pollen-masses are brought close together; not, however, before the insect to

which they are attached has had time to fly to another flower. On reaching this new flower the hair bearing the pollen will be guided into the slit, and, too large to be drawn through, will be detached, and so left in the exact position to send the pollen-tubes into the stigma.

Insects visiting the flowers often have cause to rue the visit. Honey-bees have often been found dead, with many pairs of glands or pollen-masses attached to them; for, visiting the flowers and extracting numbers of the masses, they become entangled, and finally perish of starvation. One entomologist, having found a beetle with many pairs of stalks and pollinia upon the hairs of its tarsi, sent a drawing of it to a scientific journal, and referred to it as possessing peculiar appendages, the like of which he had not before seen, and which he supposed to belong really to the hairs to which they adhered. But it was soon pointed out that, instead of natural appendages, they were those acquired in peregrinations over clusters of Milkweed blossoms.

FIG 6.—Leg of beetle, with pollinia attached to the hairs.

Notwithstanding the numbers of insects frequenting the flowers, it is noticeable that only a few of them produce seed; for the pollen-masses *must* be removed from the sacs and *must* be inserted into the slits before the stigma can be fertilized. Sometimes, it is true, the grains, while yet in the sacs, send tubes into the stigmas; but these tubes are inoperative, and do not enable the flower to set a pod. It is quite rare to find more than two pods produced out of a bunch of, perhaps, fifty flowers; and often there will be only one or two pods on the whole plant. But what the plant lacks in the number of pods it makes up in the number of seeds found in each one. These seeds are packed so closely and tightly together that a single pod contains an immense number. They are provided, too, with such an admirable appendage for being wafted through the air, and this serves its purpose so effectually, that even a few pods are sufficient to stock a large tract of country.

The peculiar arrangement of the pollen-grains in masses is

something which is found in but one other family. This is the Orchid family. In this order the peculiarity has been more fully developed than in the first one, and the differentiation is greater. Ordinarily in the Orchids the caudicle, or stem, contracts and bends the pollinium forward; in the Asclepiads the appendage twists in drying, and the two pollinia are then brought close together. In both cases the pollen-grains are only then in a position to reach the stigma. Darwin has demonstrated that the contraction of the caudicle of the Orchid pollinium is necessary to prevent its being put back into a cell similar to the one from which it was taken. In the Asclepiads the twisting of the appendage brings the two pendent pollen-masses together, and enables them to slip into the slit between the hoods, and be thus in a position to reach the stigma.

FIG. 7.—Pollinium of *Orchis*.

The appendage to the seed of the Milkweed is of the same character as that found in the Dandelion, the Thistle, and many other plants. In all it serves the same end. But in some species of the family the coma has the peculiarity of expanding very rapidly on exposure to the air. In one of these (*Gonolobus obliquus*) it is recorded by Mr. Meehan that the expansion of the coma is so rapid as to be compared to a stroke of lightning. He says it is followed by the eye with difficulty. While one instant it is enclosed in the capsule closely packed away, as soon as it is exposed the hairs of the coma fly round and form a perfect hemisphere. This is a necessity, because if it did not so occur, the seeds, being heavy, would fall to the ground close to the parent plant, and the purpose of the development of the feathery appendage would be defeated; but, drying so rapidly, they are in a condition to be carried by the lightest wind to great distances.

While in the common Milkweed the milky juice of the stem is so abundantly developed, it is a little remarkable that in another species (the Pleurisy Root) it is entirely wanting. The flowers are similar, and the sap is so acrid as to cause the plant to be rejected by all animals. It grows in very poor soil, and has but few plants to contend with; so that the acridity serves to protect it in much the same way as if it had a milky juice.

The sixty or more species of Asclepias are, with two exceptions, confined to the American continent, and the amount of milky juice varies in the different species. The acridity of those species which have no milky juice is a sufficient protection, however, from the attacks of herbivorous animals.

Other genera of the order present, in their turn, various features of interest. *Stapelia* is a genus of about one hundred species, all of them found in the Cape of Good Hope region. They are peculiar in having thick, fleshy stems, generally with small scales in place of leaves borne on the angles of the stems. The flowers are mainly star-shaped, starting out at various points on the stem, and are remarkable for their disagreeable, carrion-like odor. This is so marked in certain species that it attracts large numbers of flies. These sometimes lay their eggs in the flowers, but the progeny, when hatched, die for want of food. The main object of the odor of the flower is to attract insects for the purpose of fertilizing it by the transfer of pollen from one plant to another. About the centre of the flower are certain black spots, which are peculiarly attractive to insects. In one species (*S. asterias*) flies have been observed to feed greedily about these spots, and it is found that the fly's tongue often gets caught in a trap situated hereabouts. When thus caught it struggles violently to escape, and, if successful, goes away with a pair of pollinia attached to its tongue, drawn from their enclosing sacs. The apparatus which catches the tongue is a veritable spring-trap, closing with a snap on the intrusion of any disturbing object. The insect, laden with the pair of pollen-masses, flies to another flower, and there places them in a position where the pollen-tubes can penetrate the stigma. Here, then, there are three interesting features to be noted,—first, the thick, succulent, leafless stems, which enable the plants to exist in dry, sandy soil, and, at the same time, furnish no inducement to any stray animal to feed upon; second, the carrion-scented flowers, which attract flies, necessary for the fertilization of the stigma; and, third, a veritable spring-trap, which catches the tongue of the little carrier, so that it flies away with the pollinia to another flower, and effects cross-fertilization.

The succulent stem may be regarded as developed because of the necessity to retain a supply of moisture in the dry, arid regions, whither the plants have probably been driven from an

inability to cope with more vigorous forms of vegetation. The scent of the flowers has been acquired to enable insects to detect the presence of the plant at a distance, while the spring-trap was a necessary contrivance to certainly secure the transferrence of the pollen from one plant to another.

Besides the genera *Asclepias* and *Stapelia*, there are others which possess points of interest, or are valuable in a commercial sense. The species of the genus *Hoya* have climbing stems, thick, succulent leaves, and clusters of waxy flowers. Hence the common name of wax-plant. Various species are cultivated, and are great favorites because of their fragrance and beauty. It is stated that the young leaves are used by the natives of Ceylon in their curries; and one curious feature of the plant is that the flowers come from the same bud year after year.

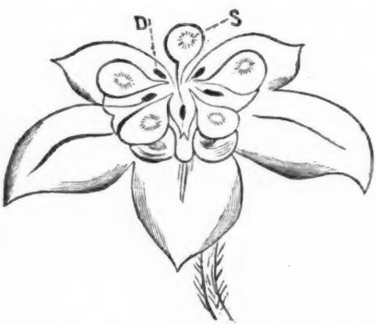


FIG. 8.—Flower of *Hoya*. S, stigmas; D, disks of pollinia.

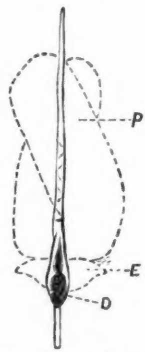


FIG. 9.—Disk and pollinia. P, pollinia; E, elastic appendage; D, disk.

The fertilization of *Hoya globulosa* possesses points of interest, the mechanism being much the same as in Asclepias. It has been described in the *Gardeners' Chronicle* for April 29, 1882, by Mr. W. G. Smith, as follows: The flowers are regular, grow in clusters, and are very fragrant. The pollen-grains are united in clusters and enclosed in pouches, five in number. The glutinous, dark-colored disks of the pollinia are the only parts of the stamens visible in an open flower. If an insect, attracted by the fragrance, alights on a flower, it almost invariably happens that one foot slips and is caught by one of the sticky disks. Some-

times four feet are entangled, and then ensues a struggle to escape. If strong enough, the fly tears itself away, but in the effort takes the pollinia attached to its feet along with it. "The basal appendages of each pair of pollen-masses," says Mr. Smith, "are elastic, and when in the pouch they are like an extended spring, but the instant the masses are drawn out by the insect's foot the spring closes, the two pollen-masses quickly cross each other and hold tightly on to the insect's little claws." The stigmas of the flower are exposed in the centre of the parts forming the apex of stamens and pistils, and these are not ripe at the same time as the pollen. It is therefore necessary for the pollinia to be withdrawn from the pouches and conveyed by the insect to another flower in which the stigmas are ripe before fertilization can take place.

Other species of the family are noted for their medicinal properties. For example, one known as *Tylophora asthmatica*, or Indian Ipecacuanha, is largely used in cases of dysentery. Others are valued for their fibre. One of these is *Calotropidis* (*Asclepias*) *gigantea*. This is spun into the finest thread for sewing or weaving. Handkerchiefs made from it were shown in one of the Paris exhibitions. A species in our own country, very common in wet or damp places (*Asclepias incarnata*), produces a long, tough fibre which could be used for many purposes. Another species (*Marsdenia tenacissima*) produces fibre so strong that the natives of some parts of India use it for bow-strings. The stems are dried in the sun, and the milky juice which exudes hardens into a substance like india-rubber; and there are other species in which this juice could be used for many of the purposes to which caoutchouc is now applied.

It is thus seen that the family of Milkweeds is useful practically, as well as interesting botanically. We use the sap in our way as the plant uses it in its own. The same tough fibre which makes the plant disagreeable to animals the human race finds useful to itself. The same sweet-scented flowers which attract swarms of insects delight us in our greenhouses; and the same curious forms of stems adapted to a plant's existence in dry and arid regions form curious features in the homes of civilized man.

METHODS OF INSTRUCTION IN GENERAL GEOLOGY.[1]

BY H. S. WILLIAMS.

WHAT I can offer on this subject must be confined to a few suggestions upon points in which I see need of improvement, and some account of the various ways in which I am attempting to apply scientific method to the teaching of geology at Cornell University.

The science of geology, like the earth, from which it derives its name, bears a kind of maternal relation to the kindred sciences. As the materials discussed by physics, chemistry, and even biology come out of the earth, so the sciences treating of them have their springs of origin, and have been separated off from that more general science now represented by geology alone. As the more exact sciences have become organized they have set up their own standards and their own more precise methods, while geology has not become quite freed from some of the ancient crudities and myths.

This peculiar relation borne by geology to kindred sciences has much to do with the peculiarities of the methods in teaching it. Geology is less exact; there are more unsolved problems, or problems the solution of which is recognized as tentative; there are more points of contact with the dark regions of the unknown than are found in the other more specialized sciences.

This doubtless arises from the fact that as human knowledge has grown and the problems have become more scientifically interpreted, and the ultimate laws have been discovered, the principles involved have been relegated to their more special branches,—to physics, to chemistry, to astronomy, or to biology.

On the other hand, when these more precise sciences come across vexatious questions too complex for either alone to handle, they toss them into the broad lap of geology, so that we are left with the more mysterious and inexplicable phenomena of nature to wrestle with as best we may.

This broad and fundamental nature of the subject-matter of

[1] Delivered at the meeting of the American Society of Naturalists, at Philadelphia, December 29, 1886.

geology tempts a superficial treatment, and the teacher of geology needs to be specially on his guard lest he fall into the discussion of mere generalities. When we discuss the principles of geology we must generalize more or less. The facts are so many and so various that it is necessary to state in condensed form the laws which may best express the characteristics common to a great number of facts or phenomena. But when the geologist generalizes he is in greater danger than teachers of other sciences of being tempted to sacrifice science to the popular interest in wonders and curiosities.

The intimate relation borne by geology to the other sciences demands a broader knowledge than is required in them.

The geologist must apply to the solution of his riddles the laws of physics, astronomy, chemistry, biology, and mineralogy, and this brings with it the temptation to confine his instruction to the announcement of the theories, while referring the student to the special science concerned for the real solution of his problems.

Again, we may observe that geology, lying between the more thoroughly specialized sciences of modern times and the philosophies and purer literary branches of learning, has not altogether lost the effects of the scholastic methods of the literary school, nor has it fully attained the perfections of the scientific school.

Literary scholarship has for its ideals the skilful use of language as a means of expressing thought, of thinking and of interpreting thought. The subject-matter of this scholarship, as we scientists look at it, is language, and therefore the learning or mere memorizing of words and forms of verbal expression, including terse formulas and abstract statements, is valuable in itself, and is directly in the line of attainment of that kind of skill sought after in literary study. But verbal expression and definition is of secondary importance to the scientific scholar. To know simply names and definitions, laws, and, I may add, statistics, without the discriminative power of the eye, or ear, or touch, does not make a scientist. This acquirement bears no closer relation to scientific knowledge than the reading of an English translation of Cæsar's Commentaries bears to a knowledge of Latin. We would never think of calling him a classical scholar who was unable to read the original text. No more should we regard him a geologist,

however well he might remember the text-book definition, who is unable to recognize and interpret geological phenomena in nature,—in the field and laboratory. Hence, in teaching geology, the mere ability to talk *about* geology, to say that Paradoxides is characteristic of the Cambrian, that Ichthyosaurus is a Mesozoic reptile, and a thousand other similar items of geological information, is of little or no practical use unless the student is taught to recognize an unlabelled Paradoxides when he sees it, and would know how to distinguish Cambrian rocks in the field. The subject-matter for the scientific scholar to acquire is found in the things and phenomena named and described, and not in the names or definitions.

In other words, the methods of literary instruction are of but limited value in teaching geology, and although we may begin with these methods, the teacher should not deceive himself with supposing that he is teaching science, or that the student is learning science, unless the lectures and text-book work are supplemented by drill in the laboratory and field. It may seem more dignified to stand up in a lecture-room before a lot of students and read off a lecture on geology, but the best results will come from the tramps and the hammerings in the ravines and railroad cuts and the study of hand specimens in the laboratory.

Our lectures may inspire the students to study, but most of what they learn will come by other methods.

We are obliged to use the lecture method, although not the ideal way of teaching science, on account of the large size of classes in our universities. Quizzes, and these written after every five or six lectures, I find of value in calling out study and thought upon the topics discussed in the lectures, and these I believe should always supplement the lecture for the best results.

In the lecture method there is one danger not met with when a good text-book is made the basis of recitations. Unless the lecturer is on his guard he will forget that his pupils are beginners, and neglect to state the essential details needed for a clear understanding of the topics under discussion. These details, when crowded by the multitude of topics he is tempted to consider, will be omitted by the lecturer because they seem to him so familiar.

To ward against this evil I give references to the pages in

the more common text-books on geology, where the student may study more explicitly the subject lectured upon. I expect, too, that the student, who will acquire any exact knowledge of the science, must give some time both to this kind of book study and to the examination of specimens arranged and labelled specially to illustrate the facts discussed.

Again, it is important to so accentuate the lectures that the grand and important lessons shall not be smothered and quite lost to sight by the innumerable names and definitions and topics with which the lecture is necessarily filled. For I hold that, in teaching a class of ordinary college students general geology, it is far more important to teach them how to treat geological problems, what the grand questions are which the geologist meets, and the right methods of attacking, of thinking about, of interpreting them, than to teach definitions, technical formulas, or lists of associated facts.

The latter are all essential for the real geologist to master, but not in the lecture-room. They must be acquired by patient study of the more exhaustive manuals and original reports, and by actual laboratory and field practice.

The work for the lecturer upon general geology is to clearly present the principles of geology, to illustrate and explain the grand features of the science. He must teach what the science treats about, what and where the problems are exhibited, how they are explained, and what laws underlie the phenomena.

While the student gathers enough to excite his interest and enthusiasm, if possible, the method of stating the facts and theories should be such as to enable him to appreciate what there is to learn, rather than to convey any notion that he is getting from the lectures a knowledge of all the essential facts of geology.

We may be able in our lectures to teach the student the alphabet, so to speak, of the science, or even to teach him how to spell or frame sentences in terms of the geological language. We may succeed in showing him how to investigate and interpret geological problems. But I take it to be of essential importance to impress upon the student that the lectures are but an introduction, that the true place to learn geology is in the field and laboratory, and the true method, that of studying over in detail individual phenomena and facts.

This is not generalizing or popularizing the subject; it is making the lectures a means of scientific training, instead of allowing them to degenerate into a glowing account of the wonders of geology.

Geology may truly be a popular subject, because of the many remarkable events and phenomena it reveals, but it is not the remarkable, the unique, and the impressive facts of geology that are the most instructive.

The awful eruption that throws out lava and ashes from a volcanic vent, or tears off the top of a volcanic cone, is not so direct an illustration of the peculiarity of vulcanism as the little bubbles which puff up the cooling lava and testify to the presence of expansive vapors or gases in association with the molten condition of the rock.

The grand cañons of the plateau district are not so valuable as illustrations of the laws of river erosion as a simple rocky ravine composed of a few strata of alternating hard and soft strata, or even the rill along the roadside after a heavy shower. But, after having once grasped the principles of river erosion, its slowness of action, the smallness of the effect in proportion to the amount of water traversing the gorge, then the cañon does become an impressive illustration of the continuity of geologic dynamics over vast periods of time,—of the immensity of deposition of sediments,—of the grand results effected by the slow elevation of continents,—and it serves to convey some conception of the length of actual time with which the geologist has to deal.

Improvement may be made in the order of presentation of the topics.

In our standard text-books we frequently find what I may call the scholastic method followed,—a method which proceeds from the announcement of principles, laws, or technical definitions to the descriptions or illustrations of facts from which they have been drawn.

As an illustration the following may be taken from chapter second of Dana's Manual. The subject is lithological geology. First we are given a brief classification of the subject, then the definition of rock; then follow three sections in the following order: 1st, the elements constituting rocks; 2d, the mineral materials constituting rocks; 3d, the kinds of rocks.

For a geologist familiar with the general subject, and as a book of information arranged for ready reference, this is as good an arrangement as could be desired. But when the science is presented for the first time to the student, is this the order in which he must grasp the details of the subject for clear comprehension? I think not.

And why is it unnatural? Because the student is asked to take the results of an analysis before he is presented with the conception of the thing analyzed. He is led to form a synthetic conception of the objects studied, built up of definitions, rather than by analysis to increase his knowledge of the object by viewing it in new relations.

Rocks are at first parts of the earth, and among themselves they first differ in their physical relations of position, structure, form, and composition. The chemical and mineral properties are secondary in order of analysis; and the microscopic appearances presented by separate mineral species constitute a tertiary set of characters.

The teacher should have regard to this order of acquisition, although, after having named and briefly described the terms, they may become for his purposes mere definitive terms with which to describe the more comprehensive laws of the earth's formation.

For this reason there is propriety in uniting physiographic, structural, and dynamical geology as a first division of the general treatment of geology, following with the stratigraphical and palæontological part as a second division.

This plan, substantially, is followed in several of the more widely used text-books, as Phillip's, Credner's, Geikie's, Leconte's, and others.

In determining the order of presentation of the facts for particular cases, I examine the order in which the facts naturally develop in the process of investigation. As a general statement of what this order is, I find it to be from the more conspicuous, the more easily grasped, and the simpler, to the less evident, the intricate, and the fundamental. This same regard to the order of acquisition of ideas is applicable to the methods of illustration.

Every teacher of natural history has more or less use for diagrams, but I have thought that blackboard sketches, although crude, made while the explanation is going on, are often more

effective in imparting the information desired than the more finished ready-made diagrams. The value of the blackboard sketch is in the fact that it emphasizes your words, makes them more vivid and expressive; with crayon in hand as you talk, the lines of the sketch become a kind of lineal gesture.

This result is particularly seen when the relations of two or more objects are expressed, or when serial or gradual changes or developments are considered, as in explaining Darwin's theory of the formation of coral reefs and islands, or the structure and growth of a common volcanic cone, or the effects of erosion in cutting through a series of hard and soft stratified rocks, and the relation of dykes to eruptive sheets, to volcanic lava-beds or fissure lava-fields.

All such phenomena are more vividly expressed to the beginner by blackboard sketches than by the more perfect diagram, and the reasons seem to lie in the fact that the student only appreciates the points to which his attention is definitely called; the large number of details expressed in the finished drawing tend to divert his thought from the essential few which are brought specially under consideration.

In teaching palæontology, in comparing genera, in pointing out variations and the relations of one form to another, I find the blackboard a great assistance.

A method specially successful of late in the teaching of biology suggests lines of improvement for the teaching of geology. The method I refer to may be called the exhaustive study of types, and such a book as Huxley's "Crayfish" may illustrate its application.

The secret of the value of this method lies in the process of taking a single object for minute and exhaustive study, examining it in all its several relations,—turning it around and throwing light upon it from every side, until the one thing is thoroughly understood in its every relation. The one object thus becomes a familiar and typical example of all the principles involved in its structure, function, or other relations. Afterwards, the widening of one's knowledge becomes a simple and also a systematic mental noting of likenesses and differences. The knowledge thus acquired, instead of being vague and general, becomes positive and precise.

In applying this method to teaching geology, I select a few

characteristic phenomena, describe them particularly, noticing the individual details, and endeavor to make the one case thoroughly understood in all its important relations, so that it becomes the illustration of the several principles involved.

Thus, in explaining volcanoes, instead of spending the time with an enumeration of statistics and formulæ, crowding the lecture with all the information possible about volcanoes, the whole lecture may be spent upon Vesuvius, its environs and history, making vivid impression of one or two typical eruptions, and, by the aid of maps of the region, pointing out the precise phenomena in the locality, sequence and results in building a cone and making volcanic deposits. With a clear notion of one such typical volcano, it is a simple matter to classify and point out the kinds of volcanoes,—the pure tufa eruption, as at Monte Nuova, the continuous lava flow, as in the Sandwich Islands,—and by means of the grand eruptions recorded of Skaptar Jokul, to gain a conception of fissure eruptions and the nature of the vast lava-fields covering now such large tracts of the surface, but without the conical mountain pêaks which we naturally associate with igneous eruptions.

In the same way in treating of river dynamics, instead of brief descriptions of the great rivers of the globe, the amount of their erosion and sedimentation, the volume and rate of their water-flow, etc., presenting a great number of condensed statistics about many rivers, a better way is to spend the time in explaining the facts and their interrelations for a single typical river.

No better example can be found for us than our great river Mississippi, so thoroughly studied and reported upon in Humphrey and Abbott's monograph. For illustration of the principles of erosion a familiar ravine, near by, is better than a large river-gorge at a distance. Niagara may well serve to illustrate the rate of erosion and as a short measure of geologic time. The cañons of the plateau district are illustrative of the laws of continuous depositions, of slow but great elevation, and furnish a longer but conceivable measure of time for geologic events.

So in all cases, where it is possible, selection should be made of a familiar and typical example, and around it should be gathered the details of facts and phenomena which will illustrate the principles discussed. By communicating a clear, detailed conception of the one example, the indistinctness and

often bewilderment arising from the array of a multitude of statistics in regard to many examples is avoided.

At first sight this method may appear like a mere popularizing of a science, and—the aspect which might be so called,—the attempt to make comprehensible and therefore interesting, what is generally not so, is worth seeking after.

Is it not this very element of exciting interest, of pleasing the hearers or readers, that made the writings of Lyell and the lectures of Louis Agassiz so attractive and also so instructive?

The boys in college learn the principles of geology in the same way that we learn new laws and principles in our deeper investigations. It is facts and phenomena first, afterwards their interpretation; and unless they gain a vivid impression of the former, they will come short of grasping the latter. The other method of memorizing the statements of the laws and principles of the science, without any clear conception of the facts to which they apply, is only a knowledge of words; it is not science; and such knowledge has no scientific value.

In *field* and *laboratory* work the main point is to teach the student to observe, to record, and properly to interpret facts as they occur in nature. This is not accomplished by simply walking over the ground and pointing out the phenomena to the class. In one way and another they must be led to see for themselves; they must gather the facts, study and arrange them. The teacher may show them how to make sections, and how to gather facts and specimens. Section after section may be made through similar series; geographical localities, altitude, thickness, dip, lithological character, and fossils should be observed, and notes and materials brought in for study. After numerous sections are thus in hand, my plan is to call for a report upon the region or formations examined, asking for detailed answers to the questions, What are the faunas? What are the differences in the several sections? What changes are seen in the nature of the deposits on passing upwards? What are the names and characters of the individual species? etc. If the student wishes to perfect himself in palæontology, I set him at work on the local palæontology and stratigraphy, causing him to make comparison of sections, of association of species and individual variations, as well as drilling him in the identifying of genera and species; using the local facts, because I find better results from the

deep and exhaustive study of what is at hand and is capable of such exhaustive treatment than is possible by the method of discursive rambling over a greater number of facts.

The materials ready at hand for us at Cornell University are Devonian; but the student who has learned accurately to identify species of a Devonian fauna has learned the relative importance of characters for classification; has learned the nature of variability, the relation of species to geological horizon, the modification of specific types with retention of generic features on passing from zone to zone; has studied the range and distribution of the species; has gained a conception of what faunal association is and how it is related to the lithological character of the deposits; I say the man who has grasped these details of the science by the use of Devonian material alone is ready to undertake investigations in any geological period, from the Cambrian to the Tertiary. The facts may differ, but the methods of research will be the same; and this method and skill cannot be attained by any amount of the mere memorizing of the names of a labelled collection of fossils.

It is a mistaken view to imagine that that kind of acquirement which only removes the Megatherium, the Ichthyosaurus, the Trilobite, and the Palæoniscus from the region of wonderland to a place among the things we have seen, is geology. So long as we use our museums as curiosity-shops and cover our ignorance with Latin nomenclature, we cannot expect to lift our science out of the region of crudities.

There is, however, some value to be derived from studying over labelled collections, but this must not be without the study of the fossils as they occur in the rocks, and the determining of the characters, the names, and the horizon, each man for himself.

And if the rocks are crystalline and not fossiliferous, this determines beforehand that there are not present the best facilities for the study of palæontology, although great museums may have been accumulated.

The natural rock foundations of the region in which a university is built thus decide the particular part of geological science which may be there taught most successfully.

To this fact may be traced the explanation why Harvard, Yale, and Amherst have been so prolific in physical geologists and mineralogists; why New York State has given us so many palæ-

ontologists; why the geologists of Pennsylvania have taught us so much about stratigraphy and the structure and products below the surface.

In each institution the natural advantages found in the accessible rock exposures of the region should be not only carefully studied, but should be made a prominent feature in all the advanced work of the college.

In conclusion, I would remark that (*a*) the fundamental nature of the subject-matter of geology, with its many still unsolved problems, its many mysteries, its many unique and wonderful facts, will tempt the instructor to deal with generalities, to rest satisfied with a superficial rather than a scientific presentation of his subject. As a means of escaping this danger I suggest a careful attention to the natural order of the acquisition of the facts,—a following of the analytical order, from the conspicuous, the evident, the general, to the special, the hidden, the individual, or, to use another form of expression, follow the order of induction from the concrete, the typical, the illustrative, to the principles involved to the formulation of the laws of nature.

(*b*) Further, I would suggest the great value of selecting a single typical illustration of each general principle, presenting it with considerable attention to details, pointing out its specific characteristics. This example, then, may be adopted as a standard for comparison with other cases which offer modification of the laws involved in the first typical case.

(*c*) In field and laboratory work the same method may be applied with good results. In this part of the study problems which are accessible, in which the student can investigate the details and gather numerous statistics mutually bearing upon each other, are to be selected. In this way the region in which he studies becomes one of the chief factors in developing his powers of investigation and in showing him how to interpret nature. He thus studies nature from the original text, instead of reading merely the translations made by others.

(*d*) In all the various departments of the science I would seek to teach the student precision and definiteness in his knowledge, and accuracy in his modes of thought, by applying the simple rule of teaching much about a few things, instead of attempting to say a little about a great many things.

THE RANGE OF VARIATION OF THE HUMAN SHOULDER-BLADE.

BY THOMAS DWIGHT, M.D.[1]

THE late Professor Broca read a paper before La Société d'Anthropologie in 1878[2] in which he described the scapular and the infra-spinous indices, and proposed them as methods of ethnological research. Briefly stated, the scapular index is the proportion of the breadth of the scapula, measured along the base of the spine, to the length, the latter being considered one hundred. The infra-spinous index is the proportion of the breadth to the length of the infra-spinous fossa, the latter being considered one hundred.

The human scapula being the starting-point, Broca understands by "length" the line connecting the highest and lowest points, although in almost all mammals this is not the longest dimension. The line showing the breadth being called AB and that of the length CD, the index is obtained by calculating $\frac{100 \times AB}{CD}$. The length very rarely coincides with the posterior border of the scapula, but runs some distance before it. The line AD representing the infra-spinous length runs from the posterior end of AB to the lower end of CD. The infra-spinous index is represented[3] by the fraction $\frac{100 \times AB}{AD}$. Professor Broca used these indices both in comparative anatomy and in the study of characteristics of race, sex, and age in man.

In all orders of mammals, with one exception, the scapular index is greater than in man. In quadrupeds it is evident that the long diameter of the bone should at least approximately coincide with the line of pressure, and consequently we find the breadth—*i.e*, the line along the base of the spine—the longer. In erect man, with his great range of movement of the anterior extremities, there is need of greater leverage for the movements of the scapula, and less need of resistance to pressure, so we find a long and narrow scapula. This condition is approached in the anthropoid apes, and even surpassed in the bats, who have a

[1] Parkman Professor of Anatomy at Harvard University.

[2] Bulletins de la Société d'Anthropologie de Paris, série 3, tome i.

[3] By a most unfortunate oversight the AB and AD are transposed in Broca's paper.

lower scapular index than man. Broca's observations on the characteristics of sex and race of human scapulæ are by no means satisfactory, owing to the small number of observations. The indices of adult Frenchmen were obtained from twenty-three individuals, of which nine were female; and those of African negroes from twenty-five individuals, of which five were female. Apparently one scapula was measured in each case.

The next year Professor Flower and Dr. Garson measured two hundred scapulæ of Europeans. They admit that it is quite possible that some of the bones belonged to members of other races, and they paid no attention to sex, which for the most part was unknown. They counted every scapula measured as one, whether or not its fellow came under observation. They measured also a few scapulæ of other races, but the series were for the most part very small. The largest were twenty-one Andaman scapulæ and twelve Australian.

M. Marius Livon also studied this subject at about the same time, and gave his results in his "Thèse pour le Doctorat," which appeared in 1879. I have never seen his essay, and know it only by references to it by Sir William Turner[1] and by M. Manouvrier.[2] He measured the bones of seventy-three Frenchmen and fifty-one Frenchwomen.

Negroes, Andamanese, and Australians have higher indices, which means broader scapulæ, and consequently of a lower type. Broca points out, however, in his remarks about negroes, that this is true only of the mean, and that individuals of both classes are found to vary very much from it. Indeed, the anthropoid apes may have at least a scapular index within the range of the variations of man. The greater obliquity of the spine in apes makes their infra-spinous angle more characteristic.

Broca claimed that, in spite of the great individual variation, this method is of value when applied to groups.

I began a series of measurements of human and of anthropoid shoulder-blades several years ago and put it aside for other work. I have recently resumed it. My original purpose had been simply to collect additional statistics, but as I went on I was much struck by the diversity of forms which the scapula presents, as well as by the variation of the indices. I became convinced both that

[1] "Challenger" Reports, vol. xvi.

[2] Revue d'Anthropologie, 2me série, tome iii., 1880.

the indices do not necessarily indicate the shape of the bone, and that they are worthless to determine the race of any single bone.

The one hundred and thirteen bones which I have called Caucasian are, like those used by Flower and Garson, rather a heterogeneous collection. They for the most part belong to the Harvard Medical School and to the Boston Society of Natural History. More than a few of them came from France. While they, no doubt, are in the main Caucasian, it is probable that there are some negro bones among them. Indeed, I know that two of the scapulæ came from the body of a negro. These are remarkable as presenting very low (instead of high) indices.

Through the kindness of Professor Putnam, who most generously put all the stores of the Peabody Museum of Archæology at my disposition, I had hoped to be able to present a large collection of figures from the bones of the mound-builders, and perhaps to make observations on many individuals of a race which was less mixed than most of those whose bones are easily obtained to-day. I was, however, disappointed, and from a cause that is easy to foresee, namely, the great fragility of the scapula. I could have had long bones in abundance, but the shoulder-blades were for the most part either in fragments, or so injured that the necessary measurements could not be made. I have the records of six scapulæ from California which are probably Indian, and of eighteen from the Kentucky mounds. The mean of the Californians is 67.25 for the scapular index and 91.05 for the infra-spinous. The mound-builders have a mean scapular index of 69.29 and an infra-spinous one of 93.75.

The following table shows the indices of Caucasian bones obtained by my predecessors and myself. Livon is the only one who has a tolerably large series showing the difference between the sexes. Broca, with a much smaller series, had different results:

TABLE I.

	Broca.	Flower and Garson.	Livon.		Dwight.
			Male.	Female.	
Scapular index	65.91	65.2	63.0	67.4	63.5
Infra-spinous index	87.79	89 4	85.4	88.8	85.8

To understand the significance of figures something more is needed than an average, which gives no hint of the range of variation, and accordingly I have arranged the figures of the in-

dices of the Caucasians and mound-builders in groups. The first row of figures shows the index, and opposite each is placed the number of scapulæ having that figure (or that figure and a fraction) for an index. The six Californians showed no extreme figures.[1]

TABLE II.

Scapular Index.			Infra-spinous Index.		
Index.	Caucasians.	Mound-builders.	Index.	Caucasians.	Mound-builders.
55	2	...	72	2	...
56	3	...	73	...	...
57	5	...	74	...	...
58	7	...	75	1	...
59	5	...	76	2	...
60	9	...	77	4	...
61	8	...	78	4	...
62	12	...	79	8	...
63	13	1	80	7	...
64	6	...	81	4	...
65	11	2	82	6	...
66	10	3	83	5	...
67	8	2	84	4	...
68	1	3	85	10	...
69	4	1	86	7	...
70	3	1	87	10	...
71	3	1	88	5	3
72	1	1	89	3	3
73	1	...	90	8	3
74	...	...	91	1	...
75	...	...	92	6	2
76	1	1	93	2	1
77	...	1	94	5	...
78	...	...	95	2	1
79	...	...	96	3	1
80	...	...	97	1	1
81	...	...	98	1	...
82	...	1	99	...	...
			100	1	...
			101	...	...
			102	1	...
			103	...	...
			104	...	...
			105	...	1
			106	...	1
			107	...	1
Total........	113	18	Total........	113	18
Mean........	63.50	69.29	Mean........	85.83	93.75

[1] There can be no question that in measurements the "personal equation" has its effect. No doubt the discrepancies would have been less if all the measurements had been made by one man. The very greatest care is needed to avoid mistakes. I was much mortified at the conclusion of this work to find inaccuracies in the measurements of two bones, the results of which it was practically impossible to rectify. Happily the errors are of little consequence.

The scapulæ from Kentucky have a decidedly higher index than the Caucasians, and this is evidently not due to individual peculiarities, for though three specimens with remarkably high indices have their effect on the average, yet the scapular index is only once, and the infra-spinous never, as low as the Caucasian mean.

Broca gives some of his extreme figures, which are very interesting. The bone with the lowest indices belonged to a Turk from Smyrna; the next lowest scapular index was furnished by a Frenchwoman, and the next lowest infra-spinous by an Arab. The highest indices belonged to an African negro, by name Tom Blaise, and the next to a black from Hindoostan.

Flower and Garson, unfortunately, make no mention of their extreme cases. For more convenient comparison I put my extremes below Broca's in the following tables:

TABLE III.

MINIMA.

		Scap. Index.	Infra-spin. Index.
Broca.	Turk from Smyrna	57.47	75.19
Broca.	Frenchwoman	60.27	....
Broca.	Arab	....	78.57
Dwight.	Caucasian (Fig. 4)	55.1	72.8
Dwight.	Negro (Fig. 10)	58.8	72.3

MAXIMA.

		Scap. Index.	Infra-spin. Index.
Broca.	Tom Blaise	76.64	111.95
Broca.	Black from Hindoostan	76.61	104.39
Dwight.	Kentucky Mound-builder (Fig. 5)	82.2	107.3
Dwight.	Kentucky Mound-builder	77.1	106.9
Dwight.	Highest scapular index among Caucasians	76.3	98.2
Dwight.	Highest infra-spinous index among Caucasians	71.8	102.0

Broca thought it likely (*assez probable*) that his limits would be but rarely passed. Table II. shows, however, that I have measured no less than twenty-two bones with a scapular index below sixty, and that five of them were below fifty-seven. The two given in Table III. are, however, the only ones in which the infra-spinous index falls below seventy-five. Turning to the *maxima*, I have no equal to Tom Blaise in both indices, which is due to the great obliquity of the spine of his scapula, an ape-like feature which the mound-builders cannot rival. One of

them has a scapular index which is decidedly higher, and they both exceed the black from Hindoostan in both respects.

Sir William Turner states in his "Challenger" report that, excluding the scapulæ of one Hottentot, the mean scapular index of several races ranged from 60.3 in the Tasmanians to 70.2 in the Andaman Islanders. This includes the results of some other observers. It would appear, however, that for some reason he has omitted also his four Ohauan (Pacific Islands) scapulæ, which have the extraordinary *means* of 78.8 for the scapular index and 117 for the infra-spinous. He found the variations in the scapular index of African blacks, male and female, to range from 57 to 81, and the infra-spinous index from 30 to 117.

Apart from the range of individual variation in the indices, this method is open to at least two criticisms: first, that there are various forms of scapulæ, which may not be without their ethnological significance, to which these indices give no clue; and, secondly, that the length of the scapula—which is of primary importance in determining the more important index, the scapular—depends in part on the development of the superior angle of the bone. In support of the first criticism I would call attention to two scapulæ (Figs. 6 and 7) whose indices are almost identical, yet which in shape differ enough to be bones of different species. I shall return to these points in the course of the discussion of the variation of different parts of the bone.

Length.—In the one hundred and thirteen Caucasians, all adults, the mean length is 16.22 cm., the extremes being 13.2 and 20.1. There are six under 14 cm. and ten of 18 or more. The mean of the six Californian Indians is 13.62, and of the eighteen from the Kentucky mounds 14.07. The range of variation in these two series is very small. The shortest bone is 12.4, and the longest 15.8, both from Kentucky. These old bones, both in size and shape, constitute a well-marked series.

Professor Mivart, in his well-known paper on the "Appendicular Skeleton of the Primates,"[1] takes several parts of the scapula for comparison. We shall consider the variation that some of these present in man alone.

The inferior angle (Fig. 1),[2] which Professor Mivart puts at

[1] Philosophical Transactions, London, vol. clvii., part 2, 1867.

[2] In Figures 1, 2, and 3 the partial outlines are drawn as though taken from the bone of the right side in every case. This is for convenience.

35° or 40° in man, presents great differences, as is shown by the appended wood-cuts. I give no measurements, as the difficulty of making accurate ones is quite out of proportion to their value. The difference is in part, but not wholly, due to the development of the surface at the lower part of the axillary margin for the teres major.[1] This muscle arises from the dorsal surface of the bone, but there is almost always a slight projection at this point from the anterior border, and occasionally it is developed into a projection of considerable size. Broca states that this is more common in negroes. I have no opinion to offer on this point, but I believe that this process does not stand in direct ratio to the size of the muscle. It is well marked on a very delicate scapula (Fig. 5), and on the other hand there is a large surface to this muscle with hardly any projection on a remarkably sharp bone (Fig. 4). An analogous case is the third trochanter, the occurrence of which, in my opinion, is quite uninfluenced by muscular development. The surface for the *teres major* projects out very strongly in the lower Simiidæ, Cebas, and Chrisothrix, according to Mivart. Its occurrence in man is probably (as in the case of the third trochanter) the appearance of a peculiarity of lower forms. The lower angle, however, varies considerably apart from the influence of this process.

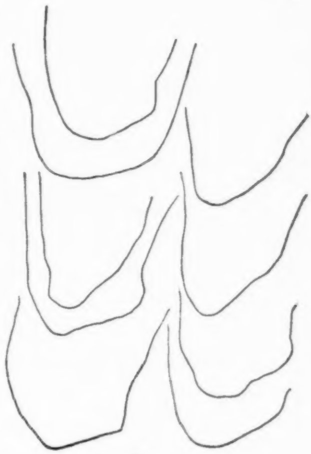


Fig. 1.

The vertebral border (Fig. 2).—The most common form of scapula presents a line slightly curved at the lower part, and then straight as far as the root of the spine, from which point it inclines slightly forward till it ends at the upper angle. The forward inclination of the upper part, though varying in degree, is, so far as I know, constant, but the rest of the line varies much. Sometimes it is almost straight, sometimes the whole border of the bone is convex, sometimes the border below the spine is con-

[1] By another oversight Broca repeatedly calls this muscle "*le petit rond.*"

cave. The different types are seen in the annexed diagram, but, better still, in some of the figures of the entire bone.

The superior border (Fig. 3) is also of uncertain shape. The superior angle cannot be considered apart from the posterior border. The diagrams show its variations so well as to make a description unnecessary. One of these is remarkable as showing the point truncated. None of these, however, show it rounded off in a way that equals the Boschiman scapula figured by Mivart. The variations of this angle are important, because they show that the length of the scapula, as used according to Broca's plan, is liable to vary according to the development of this angle. The

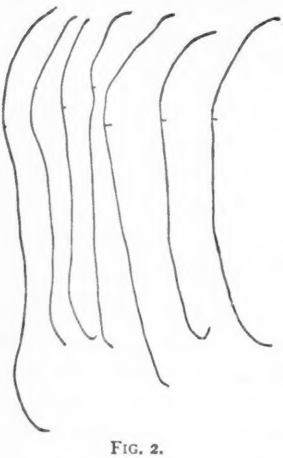


FIG. 2.

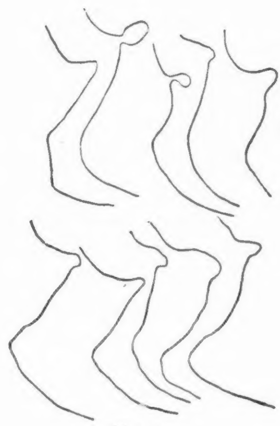


FIG. 3.

bone with the truncated angle has of course a scapular index decidedly different from the one it would have if the posterior and superior borders had been prolonged till they met in a sharp point. The differences in depth of the supra-scapular notch, which ranges from the merest deviation of the course of the superior border to a deep notch and then to a foramen, are well known. I have one specimen in which there is a foramen below a deep notch that is almost bridged over. It is the only case of the kind I have ever seen. The only allusion to its occurrence that I know of is in Humphry's "Human Skeleton."

Variations in the concavity of the body of the bone should also be mentioned. If a scapula be laid on a table with the ven-

tral surface downward, it will usually rest on three points,—the coracoid, and the superior and inferior angles. The vertebral border, as a rule, forms an arch, the highest point of which is sometimes about 2 cm. from the table. In other cases this border barely leaves the table, and sometimes one or both of the angles mentioned are bent dorsally, so as no longer to be points of support.

On the dorsum the course of the spine and acromion deserve attention. By comparing the scapular and infra-spinous indices we get some idea of its obliquity. A high infra-spinous index with a moderate scapular index shows, of course, a greater obliquity, which is an ape-like peculiarity. When both are very high it shows simply a short, broad scapula. I called attention to the fact that one of the Kentucky mound-builders had a higher scapular index but a lower infra-spinous one than Broca's negro, Tom Blaise, which means that the former had the relatively broader scapula, but the latter the more oblique spine. A study of the one hundred and thirteen Caucasian shoulder-blades shows that the two indices present no great discrepancies. The average scapular index being 63.50 and the infra-spinous 85.83, I find but three with a scapular index of between 64 and 65 which have an infra-spinous index below 85, and of these the lowest was 82.5. I find none at all with a scapular index above 65 and an infra-spinous below 85. Conversely, only seven having an infra-spinous index above 86 have a scapular index below 63. The lowest of these is 61.

Professor Mivart states that when the bone is so held that the long axis of the glenoid cavity is vertical, and that cavity is opposite the eye of the observer, the acromion is almost always higher than the coracoid in man, troglodytes, and hylobates. I do not remember any exception to this rule in man, but I find a good deal of variation in the direction of the line formed by the projecting edge of the acromion when the bone is thus held. It is not easy to determine what angle it forms with the horizon, and I shall give the mean very vaguely, as probably in the neighborhood of 45°, but I have seen it reach at least 65° on one hand and fall to 30° or less on the other. These two extremes are shown in Figs. 12 and 13. I have been unable to find that either of these degrees of inclination is associated with any particular shape of the bone.

The study of the range of variation in these separate parts leads one to the conclusion that very remarkable scapulæ could be constructed by a judicious selection and union of the most striking individual parts; but it would, I think, be difficult to make more remarkable ones than actually occur. I shall now call attention to some of the most curious specimens. Figs. 4 and 5 show respectively the lowest and the highest indices. The breadth is the same in each, but the length of the latter is little more than two-thirds of that of the former. The process for the teres major, though small, is clearly shown on the scapula of the mound-builder, but the other bone has a larger surface for the origin of the muscle, though there is but a slight projection at the anterior edge, which is confirmatory of the views expressed above. Figs. 6 and 7 have already been alluded to as widely different forms, having almost identical indices. Each is a peculiar bone, but the sharp one is the more uncommon. Figs. 8 and 9 are also in strong contrast to each other. The posterior borders have been figured, but the striking effect is shown in the figures of the whole bones. Each is very peculiar and in a different way, though neither has a remarkable index. Fig. 10 represents a wonderfully long bone,[1] being 20 cm. It is a remarkable specimen, and is among those having the lowest indices. The scapular index is 56.5, and the infra-spinous 76.3. The original of Fig. 11 (scapula index 58.8 and infra-spinous 72.3) is figured because it belonged to a negro and yet had indices far below the mean of Caucasian bones. A comparison of these bones shows assuredly remarkable diversities of form. It is easy to find bones of different species of animals that differ less from one another than do these human ones. I am unable to say what remarkable forms might be seen in a large collection of the shoulder-blades of the Felidæ, but I know that a small collection shows no such range. Even the scapula of the bear differs no more from that of the tiger than some of these from one another. A few notes on the anthropoid apes will be found in the appendix.

What influence the height, the muscular development, the health, and the occupation of the individual may have on the shape of the scapula, and indeed on the skeleton in general,

[1] The mate to this bone is the longest I have measured, exceeding it by more than 1 mm., but it has, unfortunately, been injured.

cannot as yet be much more than guessed at. The question suggests a field for inquiry, which has as yet hardly been opened, but which in the course of years may bear a rich crop. Something has been done in this direction by Mr. W. Arbuthnot Lane, of London.[1]

Livon found that in women both indices were higher than in men, while, as above stated, Broca found the reverse, but in very small series. I do not feel convinced that Livon's are large enough to put the fact beyond question, and certainly it would be rash to draw any conclusion as regards a single individual. Probably the actual size of the bone, and more particularly that of the glenoid cavity, are the best indications of the sex that the bone offers, and these are of but little value.

It must be remembered that the great range of individual variation does not necessarily destroy the value of Broca's indices, but it shows that the method must be applied to large series of bones from well-marked races. It is gratifying to find this view supported by no less an authority than Sir William Turner, who writes, "For I gather from my own measurements and those of other observers, that the range of variation in the relative length and breadth of the scapula is very considerable in the same race, so that it needs a large number of bones to enable one to obtain an accurate idea of the mean of any race."[2]

APPENDIX.

THE INDICES OF ANTHROPOID APES.

Both Broca and Flower and Garson published the indices of anthropoid apes in their papers, which have been referred to so often. As the number of observations is necessarily small, I am glad to be able to offer a few additional ones. Broca gives the indices of ten gorilla skeletons, of five chimpanzees, of one orang, and of seven gibbons. Flower and Garson give the indices of sixteen bones of the gorilla, of twenty-one of the chimpanzee, of seventeen of the orang, and of eight of the gibbon.

[1] The Pathology of Changes produced by Pressure in the Bony Skeleton of the Trunk, Guy's Hospital Reports, vol. xliii., 1886.

[2] It is proper to mention that this paper had been written and sent to the NATURALIST before I had seen Professor Turner's remarks on the scapula in the "Challenger" Reports. Through the courtesy of the editors I have had an opportunity to modify my paper here and there by quoting from his work.

To these I can add the indices of thirteen shoulder-blades of the gorilla, eight of the chimpanzee, and two of the orang.[1]

	Broca.		Flower and Garson.		Dwight.	
	Scap. Ind.	Inf-spin. Ind.	Scap. Ind.	Inf.-spin. Ind.	Scap. Ind.	Inf.-spin. Ind.
Gorilla..........	70.38	126.05	72.2	132.5	70.1	131.7
Chimpanzee...	68.52	130.23	69.9	133.8	68.4	129.1
Orang...........	69.27	97.46	77.6	103.8	73.6	89.7
Gibbon	96.97	198.56	96.5	201.2		

Below are the highest and lowest indices that I found in gorilla and chimpanzee:

		Scapular Index.	Infra-spinous Index.
Gorilla	Highest........	76.6	153.3
	Lowest.........	66.1	116.0
Chimpanzee...	Highest........	72.8	136.0
	Lowest.........	66.1	117.5

These figures show that the highest scapular index of the gorilla and chimpanzee is sometimes, though very rarely, surpassed in human bones. I say nothing of the orang, having measured the bones of only one adult skeleton. The case is different, however, with the infra-spinous index, as the lowest of the gorilla and chimpanzee exceeds the highest human one.

Description of Plates.

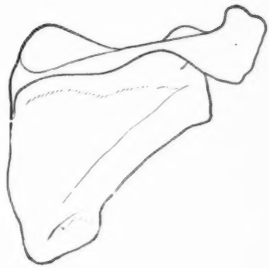
The views of the dorsum of the scapula are all on the same scale. Figures 12 and 13 are not on precisely the same scale as the others. Figures 6 and 13 are from the same bone. All but 5 and 11 are presumably Caucasian.

		Scapular Index.	Infra-spinous Index.
Fig. 4.	....	55.1	72.8
" 5.	From Kentucky mounds.........	82.2	107.3
" 6.	....	67.8	91.4
" 7.	....	67.8	90.6
" 8.	Two opposite forms............	69.4	97.2
" 9.	Two opposite forms............	61.5	91.4
" 10.	A very long bone....................	56.5	76.3
" 11.	Negro..................................	58.8	72.3
" 12.	Show extreme degrees of inclination of the acromion.		
" 13.	Show extreme degrees of inclination of the acromion.		

[1] In spite of a foot-note on p. 75 of Broca's paper, I confess to some doubt as to whether his figures of ape measurements refer to the number of skeletons or to the number of scapulæ. I have followed Flower and Garson, who reproduce his table, in stating it as I have in the text. My own figures, like theirs, refer to individual bones.

PLATE XX.

4



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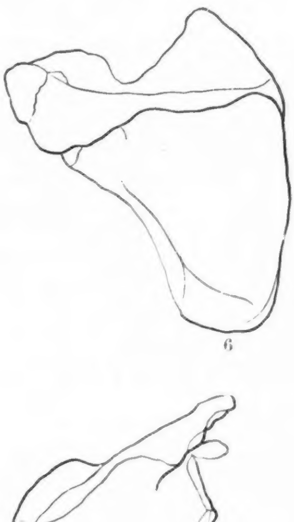

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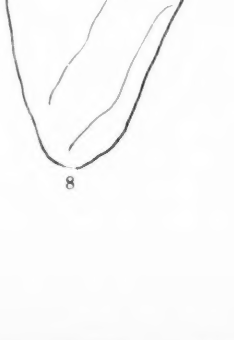

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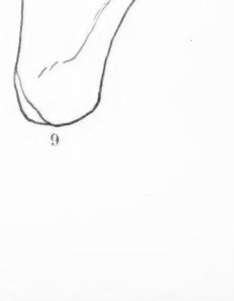
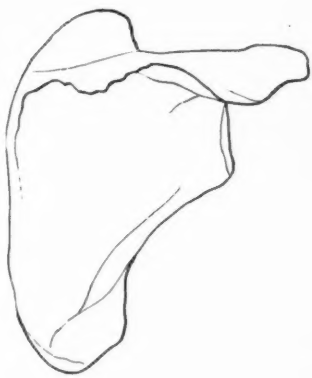


9

PLATE XXI.

10



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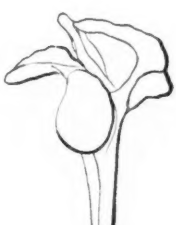
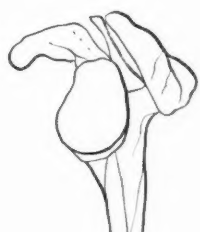


12



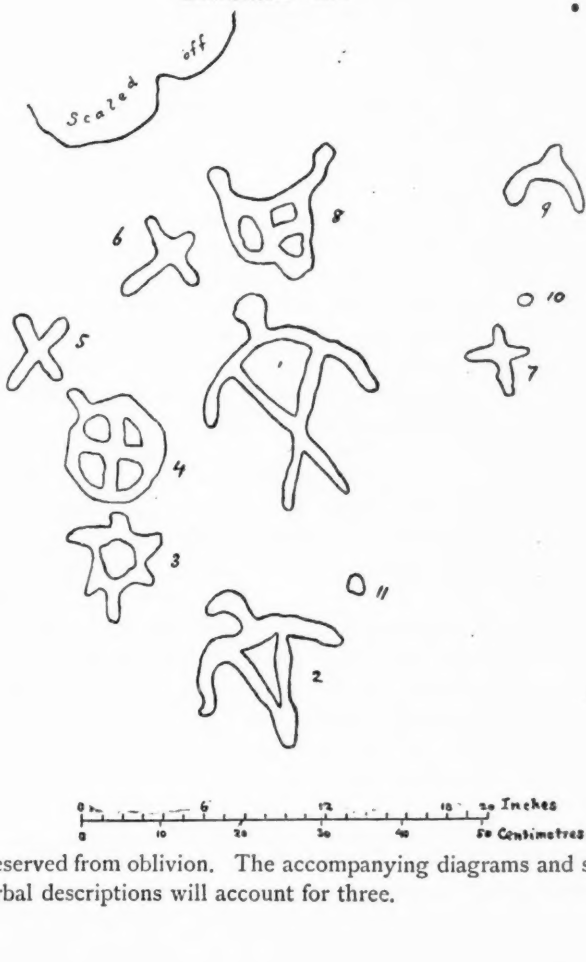
13

INCISED BOULDERS IN THE UPPER MINNESOTA VALLEY.

BY T. H. LEWIS.

THERE are other inscribed rocks in the same region besides those of the Thunder Bird's Track described in the AMERICAN NATURALIST for May, 1886, which, like them, should be

DIAGRAM No. 1



preserved from oblivion. The accompanying diagrams and short verbal descriptions will account for three.

This boulder is in the edge of the public park, on the north end of the plateau at Brown's Valley, Minnesota. The plateau is about forty feet above the Minnesota River there. The boulder has a flat surface with a western exposure; is irregular in outline, and is about five feet eight inches in diameter, and firmly imbedded in the terrace.

Fig. 1 is the central figure, and undoubtedly represents a man, although the form is somewhat conventional.

Fig. 2 represents a bird.

Fig. 3 represents a tortoise.

Fig. 4 is a cross and circle combined, but the circle has a groove extending out from it.

Figs. 5, 6, and 7, although somewhat in the shape of crosses, probably represent bird-tracks.

Figs. 8 and 9 are nondescript in character, although there must be some meaning attached to them.

Figs. 10 and 11 are small dots or cups cut into the boulder.

The figures as illustrated are one-eighth of their natural size, and are also correct in their relative positions one to the other. The work is neatly done, although the depth of the incisions is very slight. In 1883, when they were traced, the pictographs were very plain; but during my last visit to this region, in the summer of 1886, the moss was gradually encroaching upon them, and it will be only a matter of a few years before they are entirely covered up.

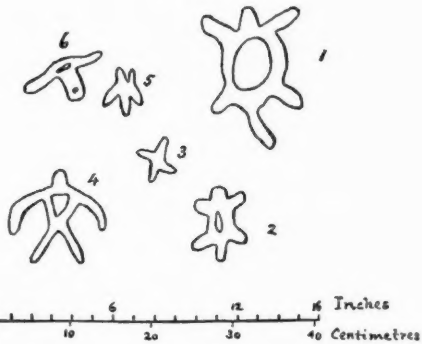
The people of the place call this boulder "the Sacred Rock," and the plateau is also called "Sacred;" but the name has no significance as regards the markings, for two lovers named the boulder without knowing that there were any pictographs upon it.

Strange as it may seem, the Indians of this region have no tradition connected with this boulder, and, in fact, did not know of the existence of the inscriptions until after their discovery by the whites, although the plateau was for many years a general rendezvous for them as a sporting-ground.

As a matter of incidental antiquarian interest here, it may be stated that twelve hundred feet to the eastward of this rock or boulder was situated an ancient enclosure or fort of the mound-builders, of about four acres, with a customary outlying mound near by. One is hardly justified, however, in speculating much

on possible relationship between these two interesting classes of relics of the very old times.

DIAGRAM No 2



This boulder is on a high terrace on the west side of the Minnesota River, one and a half miles south of Brown's Valley, and is in Roberts County, Dak. It is oblong in form, being three and a half feet in length, two feet in width, and is firmly imbedded in the ground.

Figs. 1 and 2 are undoubtedly tortoises.

Fig. 3 is probably intended to represent a bird-track.

Fig. 4 represents a man, and is similar to the one at Brown's Valley.

Fig. 5 is a nondescript of unusual form.

Fig. 6 is apparently intended to represent a headless bird: in that respect greatly resembling certain earthen effigies in the regions to the southeast.

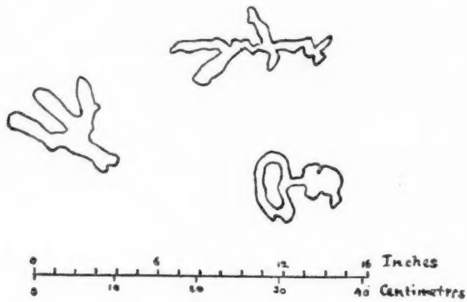
The figures are about one-fourth of an inch in depth, and very smooth, excepting along their edges, which roughness is caused by a slight unevenness of the surface of the boulder.

This boulder is only a short distance from one previously described as "Thunder Bird's Track's Brother," some four miles northwest of Brown's Valley, and, like No. 2, is in Roberts County, Dak.

The figures here represented are roughly pecked into the stone, and were never finished; for the grooves that form the pictographs on other boulders in this region have been rubbed

until they are perfectly smooth. The face of the boulder upon which these occur is about two feet long and one and a half feet in width.

DIAGRAM No 3



There is a Dakota tradition relating to these incised boulders about as follows:

In olden times there used to be an object that marked the boulders at night. It could be seen, but its exact shape was indistinct. It would work, making sounds like hammering, and occasionally emit a light similar to that of a fire-fly. After finishing its work it would give one hearty laugh, like a woman laughing, and then disappear. The next morning the Indians would find another pictured boulder in the vicinity where the object had been seen the night previous.

The above is only given to show how the Indians account for these incised boulders.

St. Paul, Minn., April 6, 1887.

EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

THE principal object of the International Congress of Geologists is the unification of geological methods. This means the adoption of a general system of nomenclature for formations and a system of coloration for maps. The utility of such a project cannot be questioned. Diversity in the practices of different countries on these points is as inconvenient as it is unscientific. It is not a matter of prime importance what names or what colors are used, but it is important that these should be uniform for the world. Two objections have been made to this project. One of these is that there is not identity, properly so called, between the geological formations of the different continents. The other is, that no system adopted under our present knowledge is adapted to express discoveries yet to be made in unexplored regions.

To the first of these so-called objections it may be replied that, since time is one, so geological ages are one for all parts of the earth. Vast tracts of sediments and intrusions have been produced contemporaneously in the past, as they are being now produced in the present. When these formations are identified as contemporaneous they should receive identical names, and be identically colored on geological maps. Of course, the beginnings and ends of the processes of deposition have not been always contemporaneous; so that we have, in variations of this kind, ground for subdivisions of minor extent and importance. But the great "time boundaries"—as they are well termed by Professor Dana—are identical in their central features for the whole earth. The parallelism may be even traced to a lesser grade of divisions, as is well known. It is only in what might be termed the third grade of time divisions based on stratigraphy, that we begin to find identifications impossible. So, of course, the work of the Congress can proceed no further in this direction.

It can, however, digest and codify the results of geological research in all countries to its lowest subdivisions. It can catalogue and compile. Thus an invaluable index to all the formations of all countries may be produced. Such a list, like all

others of the kind, would have to be continually enlarged by new accessions, as in all other departments of science. Thus is answered the second of the objections above referred to.

The above remarks apply both to a system of nomenclature and to a system of coloration. Major J. W. Powell, of the United States Geological Survey, has entered a protest against the adoption of the system of colors generally in use, and has endeavored to secure the adoption of one of his own devising. The following is an extract from a letter which was presented to the last Congress—that of Berlin[1]—by Major Powell:

"It will be observed that in its fundamental principles this system (that in use by the United States Geological Survey) is the antithesis of that in common use (and represented by the European map). With the evolution of geologic science there grew up a system of symbolic, and sometimes denominative, conventions for the representation of geologic phenomena, in which the conventions are designed to suggest the characters and relations of the phenomena. It implies a classification of the phenomena in which each element is properly correlated with each other element, and in which the sum of the recognized elements forms a complete and symmetric whole. In view of the manner in which scientific classification is effected, it involves conference among geologists concerning obscure and doubtful points, in order that a consensus of opinion may be secured; and it requires modification of classification and consequent repetition of conference with each important geologic discovery. Though natural and simple in its inception, the fully developed system is highly artificial and cumbrous. In the system here advocated, the conventions, both symbolic and denominative, are purely arbitrary. No classification save a semi-arbitrary allocation of the grander divisions of the geologic column is necessarily implied in this system, but any classification may be adopted without affecting its integrity; it affords the means of immediately representing new discoveries, and of either tentatively or finally distinguishing phenomena of doubtful significance; and it permits modification of classification, the maintenance of diverse classifications, and the development of classificatory theories at all stages of investigation. Though resting on a partly artificial basis, it is simple and natural in its application.

"The old system is ideographic, connotative, and analytic; the new is alphabetic, denotative, and synthetic; the old system trammels the observer by prescribing rules to which his obser-

[1] The Work of the International Congress of Geologists, and of its Committees, by Dr. P. Frazer, Secretary of the American Committee, 1886, p. 107.

vation must conform, while the new encourages originality by allowing the utmost latitude in expressing the results of observation; the old system tends to retard the development of geologic science, and to restrict its practical application by explicitly postulating its completeness, while the new promotes geology and extends its useful applications by providing the means of expressing discoveries in new as well as in old lines of investigations."

This letter, so far as we understand it, postulates both the objections we have mentioned above, and which we have shown to be groundless.

The Congress of Berlin did not think it advisable to change the system of coloration which had been, in its main features, in use for half a century, and the American Committee has accepted its decision. In this the committee has adopted the views of utility generally entertained in Europe. The committee, at its Albany meeting, however, expressly insisted on the necessity of incorporating into the general system all new and additional details to be derived from the explorations conducted in non-European countries, thus providing for the contingency referred to by Major Powell in the letter above quoted.

A great deal of labor devolves on the Congress and its committees. Their only reward is the belief that their work is a useful one, and the confidence that, if well done, it will endure, so far as it goes, as a permanent standard of estimation for the entire world, and for all time.

RECENT LITERATURE.

Proceedings of the American Society of Microscopists.[1]—The most notable of the papers read at the Chautauqua meeting of this society were the address of the president, Dr. Thomas J. Burrill, on bacteria and disease; Professor Hamilton L. Smith's contribution to the life-history of the Diatomaceæ; the papers of H. A. Weber and Thomas Taylor on butter and its adulterations, and that of Dr. George E. Fell on *Demodex folliculorum* in diseases of the human face. The first of these is an interesting presen-

[1] Proceedings of the American Society of Microscopists, Ninth Annual Meeting, held at Chautauqua, N. Y., August 10, 11, 12, and 13, 1886. Buffalo, N. Y., 1886, pp. 243, pls. 7.

tation of the part played by bacteria in disease, and gives many facts which fully support his conclusions. Dr. Smith's elaborately illustrated paper is better than most of the American diatom literature, as it deals with structure rather than with "resolution." The papers upon the detection of adulterated butter seem conclusive that the microscope alone is not sufficient to decide in all cases, or, at least, until new tests are discovered.

There can be no doubt that this society is doing a good work, and while it is the means of publishing much that is crude, and which might better be left in manuscript, it still serves as a centre for many who otherwise would not belong to any scientific association. To the charge that sufficient censorship is not exercised in the acceptation of papers for publication, the much larger American Association for the Advancement of Science is equally open. Indeed, such criticism applies with much more force to the latter than to the former association, for with a total of about three hundred and seventy-five members the Microscopical Society have a very substantial financial balance on hand, while the larger American Association, with a membership of eighteen hundred and eighty-six, are several thousand dollars in debt.

The Fourth Report of the Bureau of Ethnology.[1]—The present volume keeps up the high standard of the series and deserves more space than our limits will allow. The report proper of the director details the operations of the bureau in the fiscal year 1882–83, while the accompanying papers, five in number, have far more general interest. Two more papers were prepared for the present volume,—one by Professor Cyrus Thomas on the burial mounds of the Northern United States, the other by Charles C. Royce on the relations of the Cherokees to the colonial governments,—but were postponed to the next volume from lack of room. The first of the papers now before us is confessedly a preliminary study by Colonel Garrick Mallery of the picture-writing of the North American Indians. In it no conclusions are drawn, but the paper, which is fully illustrated, aims to present the material already collected as a guide for future collections. Notwithstanding this fact the paper is of great interest, and possibly gains from the fact that each reader is able to form his own conclusions unwarped by any theory of the writer. The impression the article creates in the present reviewer is that the simplest explanation of any pictograph is most likely to be the right one, and any forced or symbolical interpretation is apt to violate the nature of at least the Indians of North America. The other articles of the volume relate to pottery. Three by Mr. William H. Holmes deal respectively with

[1] Fourth Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1882–83, by J. W. Powell, Director. 4to, pp. 63 + 532, pls. 83. Washington, 1886 (1887).

the "Pottery of the Ancient Pueblos," the "Ancient Pottery of the Mississippi Valley," and as a corollary thereto the "Origin and Development of Ornament in Ceramic Art." Mr. F. H. Cushing gives a study of Pueblo pottery as illustrative of Zuñi culture-growth. These papers afford ample illustrations of the laws already laid down of the development of the ceramic art, and are to be regarded as proving and confirming the gradual evolution of the potter's trade, rather than as advancing new ideas. This, however, must not be taken as adverse criticism, but, on the contrary, as a recognition of an important point in the articles. In connection with them the reader should refer to Professor F. W. Putnam's recent paper on "Conventionalism in Ancient American Art" (*Bulletin Essex Inst.*, xviii., 1887), to which we shall have occasion to refer again.

Beal's Grasses of North America.[1]—This volume is, in fact, Part I. of a large work the second part of which, we are informed in the preface, is in preparation. When completed it will be the most important work on grasses ever brought out in this country. The part before us includes seventeen chapters devoted to the following subjects,—viz., structure, form, and development of grasses; the power of motion in plants; plant-growth; classifying, naming, describing, collecting, studying; native grazing-lands; grasses for cultivation; early attempts to cultivate grasses; testing seeds; some common weeds; grasses for pastures and meadows; preparation of the soil, and seeding; care of grass-lands; making hay; look the world over for better grasses, and improve those we now have; grasses for the lawn, the garden, and for decoration; the Leguminosæ, pulse family; the enemies of grasses and clovers; the fungi of forage-plants.

It will thus be seen that the range of topics is much wider than that which we usually find in books designed for popular use. In fact, it is doubtful whether many farmers will care much for the first three or four chapters; but, for all that, it is a hopeful sign when an author who is as well acquainted with the farming classes as Dr. Beal is, will deliberately open his book with a scientific discussion of structure, form, and development. Many a farm boy, in consulting this book, will be inspired with a desire to learn more about the methods of scientific study.

In the first chapter there are many matters touched upon which are interesting to the scientific botanist. The closed sheaths of some grasses and the partially-closed ones of many others are referred to, and some interesting figures are given. The mech-

[1] Grasses of North America, for Farmers and Students, comprising chapters on their physiology, composition, selection, improving, cultivation, management of grass lands; also chapters on clovers, injurious insects, and fungi. By W. J. Beal, M.A., M.Sc., Ph.D., Professor of Botany and Forestry in Michigan Agricultural College. Published and copyrighted by the author. Agricultural College, Mich., 1887. Pp. xiv. 457, with 175 figures. Price, $2.50.

anism for opening and closing the leaf-blades is discussed at some length, and amply illustrated. Many a botanist will here find a fuller account of the curious "bulliform cells" of the grass-leaves than he can readily find access to elsewhere. The torsion of the leaves is another curious subject to which some attention is given. "In half or more of the grasses examined, the whole or a majority of the leaves, by a twist of the lower portion of the blade, turn 'wrong side up' and expose the lower side to the sunlight."

The style of the author is well adapted to the purpose of the book, and no farmer need hesitate to purchase it for fear of its being too technical. The mechanical execution of the book is good, the illustrations are accurate, and the printing is well done upon good paper. Some typographical errors mar the pages here and there; but these can easily be corrected in a second edition, which will certainly be demanded. The author is to be congratulated upon the successful completion of this valuable book. The second part will be looked for with keen interest.—*Charles E. Bessey.*

RECENT BOOKS AND PAMPHLETS.

Smithsonian Institution.—Annual Report of the Board of Regents for 1884. Part II. Report on the U. S. National Museum, by G. B. Goode; with papers on the collections, by O. T. Mason, J. Murdoch, F. W. True, etc.

White, F. E., Dr.—Hygiene as a Basis of Morals. Reprinted from Popular Science Monthly, 1887. From the author.

Stone, G. H.—Terminal Moraines in Maine. From the author. 1887.

Giard, M. A.—Sur la castration parasitaire chez *l'Eupagurus bernhardus* Linné et chez la *Gebia stellata* Montagu. 1887.—Sur un Copepode parasite de *l'Amphiura squamata.* 1887. Both from the author.

Boulenger, G. A.—On New Batrachians from Malacca.—Remarks on Dr. A. Strauch's Catalogue of the Geckos in the Zoological Museum of St. Petersburg.—Description of a New Tailed Batrachian from Corea.—On New Fishes from the Lower Congo.—On a New Calamaria from Borneo.—A Synopsis of the Snakes of South Africa.—Description of a New Megalophrys. All from Ann. and Mag. Nat. History, 1887.

Halsted, B. D.—Bulletin of the Iowa Agricultural College, 1886. From the author.

Stevenson, J. J.—A Geological Reconnoissance of Bland, Giles, Wythe, and portions of Pulaski and Montgomery Counties, Va. 1887. From the author.

Lighthall, W. D.—Sketch of a New Utilitarianism. Montreal, 1887. From the author.

Cook, G. H.—Annual Report of the State Geologist (N. J.) for 1886. From the author.

Mark, E. L.—Simple Eyes in Arthropods. Bull. Mus. Comp. Zool. Harvard, 1887. From the author.

Woodward, A. S.—Notes on some Post-Liassic Species of Acrodus. Geol. Mag., 1887. From the author.

McCalley, H.—On the Warrior Coalfield. Geol. Surv. of Ala. From the author.

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GENERAL NOTES.

GEOGRAPHY AND TRAVELS.

General.—It is pointed out by Ed. Heawood, in a recent number of the *Proc. Roy. Geog. Soc.*, that the relations of length of the eight principal rivers given by General Tillo would be greatly altered were the general course taken, and the minor tortuosities left out. The Nile would unquestionably then be the longest river (3100 miles), the Yang-tse-Kiang (2750) and Yenesei (2700) would exceed the Amazons (2600), and this the Mississippi (2500), while the Congo would equal the Mississippi, and the Amur (2200) and Mackenzie (1800) would come after the Hoang-Ho, Obi-Irtish, Lena, and Mekong.

America. MOUNTS HOOD, ST. ELIAS, AND WRANGEL.—Heights of mountains and lengths of rivers seem to be rather good exercises for memory than ascertained facts, yet we must presume that triangulation is gradually bringing the mountains at least into their proper place. Mount Hood, in Oregon, has undergone great reduction by this means. Once "roughly" estimated at 17,000 feet, and "closely" at 16,000, a triangulation brought it down to 13,000; an aneroid barometer is said to have made it 12,000, and a mercurial barometer reduced it to 11,225. Mount St. Elias has by similar processes been elevated from D'Agelet's

estimate of 12,672 feet to 19,500, according to the triangulation of Mr. Baker. This may yet undergo some change, but from the account of Mr. Seton Karr it appears that the breadth of its form and the high mountains behind it caused Mount St. Elias to be underestimated, while the isolated position of Mount Hood caused the reverse. It is now stated that Mount Wrangel, some distance to the north of Mount St. Elias, rises 18,400 feet above the forks of Copper River, which are 2000 feet above the sea. If this estimate, made by Lieutenant Allen, is correct, Mount Wrangel is 1000 feet higher than Mount St. Elias, so that after all the United States possesses the highest peak on the North American continent.

ALASKA GLACIERS.—The country that intervenes between the St. Elias Alps and the sea, from Cross Sound to the Copper River (Alaska), with the exception of small areas of flat land east of Yakatat Bay, and east of Icy Bay, consists entirely of glaciers, the terminal moraines of which are so extensive that the ice lies buried under millions of tons and hundreds of square miles of loose rocks which it has carried down from the mountains. The Agassiz Glacier is probably about six hundred square miles in extent, while the Great Guyot Glacier, west of it, is of quite unknown area. The early navigators mistook the nature of the country. Vancouver describes it as "a barren country, composed of loose stones," and La Perouse mistook the protruding ice for snow lying on the ground.

Africa. THE MAKUA.—The article by J. T. Wills, entitled "Between the Nile and the Congo," in the May issue of the *Proceedings of the Royal Geographical Society*, is sad reading. It gives the history of the explorations carried on, and also of the wars and intrigues that have followed one another in the fertile water-shed of the Nile. Clearly the chief result of European exploration and feeble Egyptian interference has been to let the slave-trading Arabs into regions before unvisited by them, and the "brave men struggling to be free" of the Soudan prove, when looked at in the light of the lives of such men as Gordon, Lupton, Gessi, and others, whose lives or liberties have been sacrificed in the attempt to maintain order, to be bloodthirsty slave-hunters. The argument of the article, based upon the comparative volumes and directions of the respective rivers, is that the Makua, or Welle, is identical with the Mobangi tributary of the Congo, and cannot possibly be the Ardhe branch of the Shari. It at any rate appears certain that the Ngala, or Mungala, is not the Makua, since the former was found by Lieutenant Baert to have a breadth of only eleven yards and a depth of five feet, while the Welle at Ali Kobos in Bassange Land (in a straight line with the Ngala) was so wide that Dr. Junker could not determine it.

Asia. THE SARASWATI.—The importance ascribed in the Vedas to the river Saraswati, there called the "chief and purest of rivers," points, as stated by Mr. R. D. S. Oldham (*Proc. Asiatic Soc. of Bengal*), to some change in the hydrography of the region, since the stream now called the Saraswati is quite insignificant. Mr. Oldham is of opinion that the Jumna, within the recent period of geology, flowed towards the Punjab, and that it gradually abandoned this course for the present one, so that at the age of the Vedas part of the waters flowed to the Punjab and part to the Ganges, under the name of the Jumna. This change of course is similar to that known to have taken place in the Brahmaputra, which during the present century abandoned its old bed and joined the Ganges. Though the old bed receives no water from the main stream except when in flood, the Hindus still call it the Brahmaputra, while the new bed is named Jumna. A dry river-bed, known as the Hakra, Sankra, or Sotar, can be traced for many miles across the Indian Desert, and Mr. Oldham gives reasons for identifying it with the Sutlej.

PREJEVALSKY'S EXPLORATIONS.—Prejevalsky's journeys in Central Asia have probably done more towards the elucidation of the orography, hydrography, and ethnography of the region than those of any other traveller. His first journey (1871–73) was across the Gobi Desert, between Kiachta and Kalgan, and thence westward to Kansu in Western China. He visited Lake Koko Nor, ten thousand eight hundred feet above the sea, entered the saline marshy tract of the Tsaidam, and owing to want of resources was forced to return when about five hundred miles from L'hasa, crossing the Gobi at its widest part. In 1876 he advanced from Kuldja on the Ili (then Russian, but now Chinese), crossed the Thian-Shan into Chinese Turkestan, struck the Tarim, and followed that river to Lake Lob. He was the first European who in modern times has succeeded in reaching this lake. In this journey he discovered the Altyn-tagh, which rises as a precipitous northern boundary to the plateau of Tibet. In 1879, Prejevalsky went southward from Fort Zaisan, in Semipalatinsk, by Lake Uliunghar, and along its feeder, the Urungu, across the Desert of Dzungaria, to that of Gobi. The Dzungarian Desert is bounded on three sides by mountains, while on the east, where the Altai and Thian-Shan approach, an isthmus of sand unites it with the Gobi. It once formed a gulf of the great inland sea, the Kan-hai of the Chinese, which covered the Gobi in distant ages. The most characteristic plant of this and other Central Asian plains or deserts is the saxaul (*Haloxylon ammodendron*) or *zak* of the Mongols, a shrub about four feet high, and six to nine inches thick near the root. It is so brittle as to be useless for building, but yields excellent fuel. The wild horse is only met with in a corner of the desert of Dzungaria, the wild camel both there and near Lake Lob. Passing through the strategic-

ally-important Chinese town of Hami, our traveller crossed the desert at its narrowest place to An-si-chau, and then rested awhile at the fine oasis of Shachau, at the foot of the Nan-shan range. Crossing the Nan-shan, he made his way, in spite of much quiet opposition from the Chinese, to the Mur-ussu, the head-waters of the Yang-tse-Kiang. An uninterrupted gigantic mountain wall stretches from the Hoang-Ho to the Pamir, dividing the great plateau of Central Asia into two parts,—the Mongolian Desert on the north and Tibet on the south. Tsaidam, or Zaidam, may be considered a part of the Tibetan plateau, but is enclosed all around by mountains; southward by the Kuen-luin, which under various names extends from the sources of the Yarkand River far into China proper, and to the north by the Altyn-tagh and Nan-shan. The wild yak, which appears to be found in herds as numerous as once those of the bison in North America, never utters a sound, while the domestic one grunts like a pig.

The pass over the Tang-la range is sixteen thousand seven hundred feet high, but only two thousand one hundred feet above the Mur-ussu, and two thousand above that of the Sang-chu, which is believed to join the Salwin. The chain of lakes, Chargutcho, Amdo-tsonak, etc., and all the streams north of Lhasa, between the Tang-la and Northern Himalaya ranges, including the Sang-chu, flow into the Nap-chu or Kara-assu, which, if not the Salwin, must be the Irawadi. Thus the upper courses of this river and of the Brahmaputra flow for an immense distance from west to east, separated by the Northern Himalayas. Entrance into L'hasa was positively refused, and Prejevalsky returned when within one hundred and seventy miles of it.

On his fourth journey (1883–85) he left Kiachta, and thence from Urga crossed the Gobi to Ala-shan. Leaving a depot at the foot of the Burhan-Buddha, one of the ranges of the Kuen-Lun, he started to explore the sources of the Hoang-Ho, known as the Odontala, or thousand springs. Crossing to the Bhu River, the Di-chu of the Tangutans, the upper course of the Yang-tse, he found it too deep and wide to cross, and proceeded thence to the valley between the Chemen tagh and the Kuen-Lun. The descent from this gradually-rising valley to Cherchen in the Tarim Desert is so easy that it was probably in ancient times the caravan route between Khoten and China. The Kuen-Lun was found to culminate in the snowy group of Jing-ri (90° E. lat.). He then crossed an unexplored plateau to Lob Nor and visited the oases of Cherchen, Kiria, Nia, and Khoten.

MR. CAREY'S JOURNEY.—Mr. Carey, of the Bombay Civil Service, has during the last two years been engaged in exploring Central Asia. His associate is Mr. Andrew Dalglaish, and the rest of the party is made up of pony-drivers and servants. Without any armed escort, but provided with a passport from

Peking, he has made his way quietly among people with whom the Russian explorer came into collision. Passing through Ladak, Mr. Carey proceeded to Northern Tibet, and thence to the plains of Turkestan, near Kiria. From Kuchar the Tarim was followed to Lake Lob. From thence the intention was to go over the Altyn-tagh, but nothing has since been heard from him.

MANCHURIA.—Since their journey to the Peishan Mountain and the sources of the Sangari, Messrs. James, Younghusband, and Fulford have visited some other parts of Manchuria. Colonists were perpetually arriving in Northern Manchuria, but brigandage is rife, and for the most part goes on unpunished, as the Manchu semi-military administration is most effete. The country is very fertile, and only needs good government and security to life and property.

GEOLOGY AND PALÆONTOLOGY.

Notes on the Geology and Lithology of Lake Superior.—At the meeting of the Denison Scientific Association, Granville, Ohio, held April 23, a paper was presented by Messrs. Jones and Tight embodying the results of an excursion to Michipicoten Bay, undertaken by members of the class of lithology, conducted by the professor of geology in Denison University. In a more complete form this paper appears in the laboratory bulletin of the same college, volume ii., art. v., from which the following abstract and the accompanying plates are taken.

The field chosen contains good exposures of three of the great classes of Lake Superior rocks now under discussion. Especially good contacts between the schists regarded as Huronian and the granites variously classed as Laurentian or local-eruptive are afforded at many places along shore. Commenting on McFarlane's description of these contacts, Wadsworth says ("Azoic System," p. 346), "His observations show clearly that both formations here are eruptive and of the same geological age." The present paper shows that McFarlane overlooked the sharply-defined contact between the great dyke of "dense basaltic greenstone, having the peculiar dolerytic glitter" (a typical coarse diabase), and the series of (here hornblendic) schists which are at places greatly contorted by the influence of the granite and the diabases. The schists can everywhere be easily distinguished from the penetrating dykes, which lie in strike or dip. They are prevailingly chloritic, containing large quantities of calcite. At more or less regular intervals are beds of schist-conglomerate, which are regarded by the writers as true basement conglomerates. The pebbles are sometimes very large, and consist of granite and felsite-porphyry, often retaining the primitive jointing planes. The schists are here and there perforated by belts of felsite-porphyry, the feldspar being chiefly oligoclase. An

interesting instance of the formation of a porphyry from the fusion of the schist-conglomerate by contact action of a diabase-aphanite or porphyrite is noted. In what may be assumed to be the centre of the fold are great beds of calcareous gneiss, often with sillimanite (?) needles. These are the only stratified granitic rocks seen, and form an integral part of the schist series. Dykes of diorite are very frequent in the schist, and in every case assimilate the adjacent schist to them very closely in general appearance, though the microscopic character may be quite markedly different. The method of occurrence suggests that the diorites are really but fused portions of the schists pressed up through the pasty yielding schist, which thus is greatly affected by the contact. The diabases, on the other hand, are of a much later origin, and perforate the granite as well as the schist. The felsite-porphyries are thought possibly to have been formed from the injection of matter from the granite below at the same time at which the diorites were formed and before some subsequent metamorphism, which involves the schist and all its intrusives except the diabases. A curious modification of some of the diorites is described, by which the long twins of actinolite have lost their pleochroism completely, although still preserving the normal angle of the optical to the crystallographic axis. The hornblende becomes exceedingly like augite in appearance and polarization. Much that has been called diorite-slate and diabase-schist, when carefully studied, can be analyzed into various intrusive diorites, closely assimilated to intervening beds of mica, and hornblendic-schist or a cherty quartz-schist so altered as to be scarcely identified. The Keweenaw series, which laps upon the eastern shore of Michipicoten Bay, is thought to occupy an original synclinal, though great erosion must have preceded the formation of the conglomerates which are the lowest members visible. On the island of Michipicoten these conglomerates are well exposed, and a careful study of their pebbles shows that they can all be referred to some one or other of the formations now visible along the north shore of the lake. The same granites, felsites, schists, and diorites can be identified. Chemical analysis does not detect copper in any part of the conglomerate studied, but everything seems to point to its origin from the amygdaloids, which everywhere cap the conglomerate and have in some places greatly metamorphosed the latter. Indeed, the writers of the paper incline to believe that some or all of the peculiar ferrugineous quartz-porphyry, forming the only acid eruptive seen upon the island, may be the result of such metamorphism of the conglomerate. Space does not permit a more extended reference to the interesting intrusives of the Keweenaw series, which deserve a careful and critical study. Microscopic sections of the rocks described are offered for exchange.—*H.*

DESCRIPTION OF PLATES.

PLATE XXII.

FIGS. 1–3. Modified chloritic schist at contact with a diorite to which it is assimilated. Figs. 1 and 3 are parallel to the lamination, Fig. 2 transverse. Fig. 1 shows decomposed crystals of orthoclase in a chloritic magma, with apatite and titanic iron. In Fig. 3 a large corroded crystal of calcite is shown as appearing between crossed nicols.

FIG. 4. A section of the large dyke of coarse diabase northeast from Michipicoten Island, at the western limit of the bay. The section shows only augite and labradorite in ordinary light.

FIG. 5. Pseudomorphs of chlorite after mica.

FIG. 6. A baveno twin of orthoclase from a granite.

FIG. 7. Diabase-aphanite toping the conglomerate on Michipicoten Island. A fine crystal of plagioclase is figured in a cryptocrystalline base.

FIG. 8. Twin of augite passing to uralite, from dyke of diabase at Dog River.

FIG. 9. View of the schist conglomerate at Dog River. Greatly reduced from a photograph.

FIG. 10. Hypothetical north and south section of the Lake Superior basin, partly after Irving.

PLATE XXIII.

FIG. 1. Section of quartz-porphyry from Michipicoten Island.

FIG. 2. Altered mica-schist from a boulder in the conglomerate.

FIGS. 3 and 4. Pseudamygdules from the diabases.

FIG. 5. Twin of augite from a granite on the north shore.

FIG. 6. Highly magnified portion of section of diabase-aphanite or porphyrite at Dog River, showing titanic iron in dendritic forms.

FIG. 7. Section of an altered diabase-porphyrite from Michipicoten Island, with concentric pseudamygdules of chlorite in stellate, polyhedral aggregates.

FIG. 8. Decaying crystal of plagioclase.

FIG. 9. Sketch map of region studied. Strike of the Keweenaw indicated by dotted lines.

Pavlow on the Ancestry of Ungulates.[1]—In this brochure the authoress recites the work done in Europe and North America towards the elucidation of the history of the origin and succession of the primitive Ungulata. Besides the literature of the subject, the University of Moscow possesses a series of casts of moulds made by Professor W. Kowalevsky from specimens of the Mammalia of the Puerco epoch in the collection of Professor Cope. The objects of the paper are stated as follows:

"1. I will present the successive modifications of the ideas of Professor Cope on the position of the group Condylarthra in the system.

"2. I will give a synopsis of the description of this group, such as has been given by Cope.

"3. I will analyze the opinions expressed by Messrs. Wortman and Schlosser as to this group.

"4. I will study the principles developed by the investigation of this group, in order to show that its different members are probably predecessors (ancestors ?) of certain orders of mammals; and,

"5. I will finally inquire whether the European fauna does

[1] Etudes sur l'Histoire Paléontologique des Ongulés en Amérique et en Europe. I. Groupe Primitive de l'Eocène inférieur. Par Marie Pavlow, Moscou, 1887.

PLATE XXII.

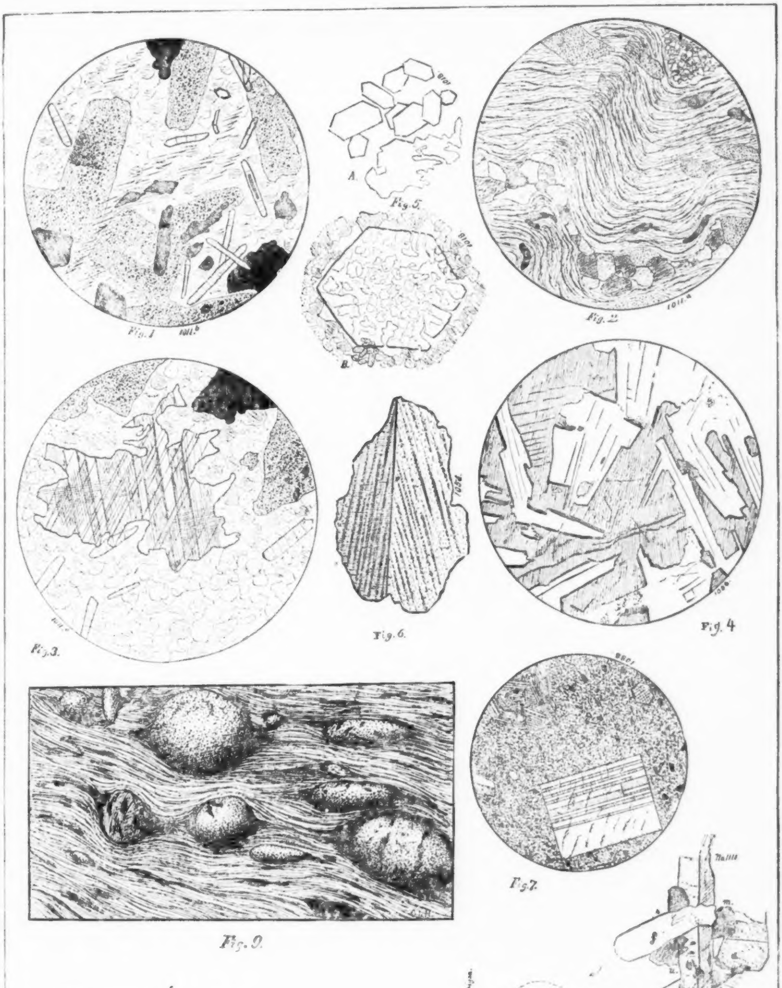

Fig. 1
Fig. 2
Fig. 3.
Fig. 4
Fig. 5.
A.
B.
Fig. 6.
Fig. 7.
Fig. 8
Fig. 9.
Fig. 10
Surface L. Superior
GRANITE
Keweenaw
Tight & Herrick.

PLATE XXIII.

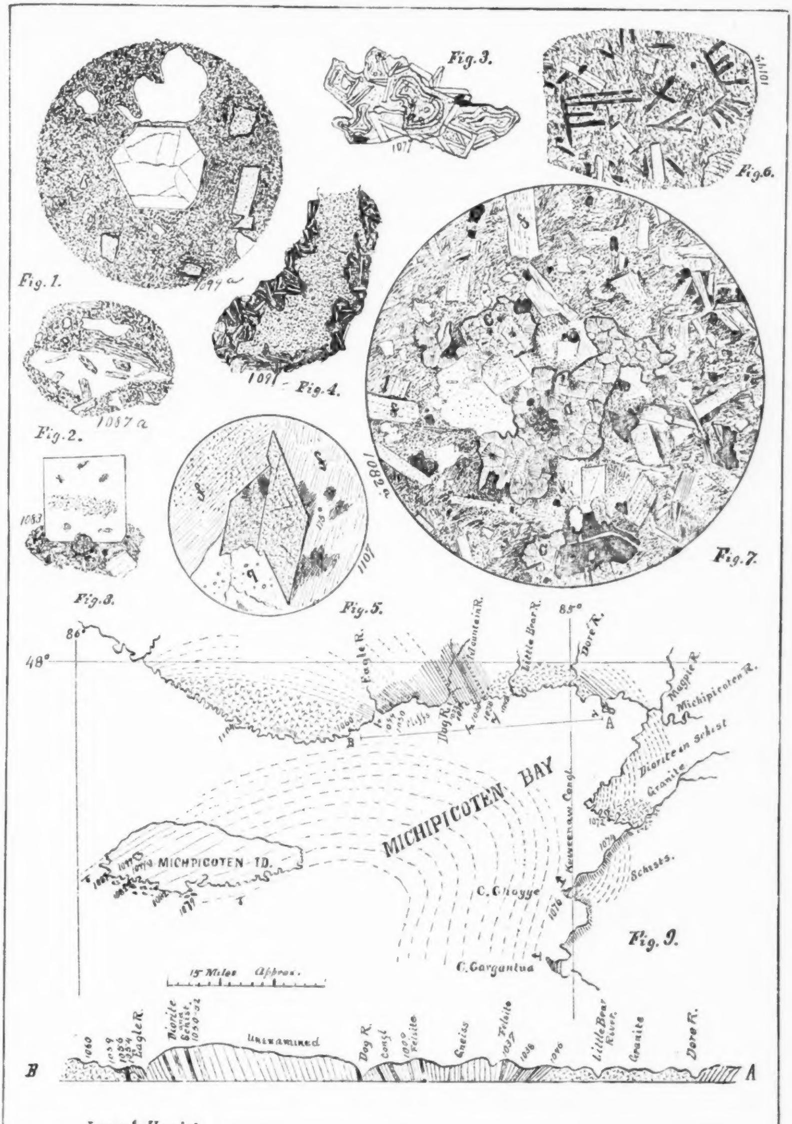
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
MICHIPICOTEN BAY
MICHPICOTEN ID.
C. Choyye
C. Gargantua
Eagle R.
Dog R.
Little Bear R.
Dore R.
Magpie R.
Michipicoten R.
Diorite in Schist
Granite
Schists.
Keweenaw Congl.
15 Miles Approx.
Unexamined
Gneiss
Felsite
Little Bear River
B
A
Jones & Herrick.

not present us with certain forms which should be placed with those which form the group Condylarthra."

These objects are realized with much fidelity, and the text is illustrated by a number of engravings, mostly from the casts made by Kowalevsky. The only exception to be noted in carrying out of Proposition 1 is the omission of reference to the opinion that the Condylarthra are ancestral to the lemuroids as well as to the other Ungulata.[1] The authoress gives a comprehensive review of the important paper of Dr. Schlosser (reviewed in these pages 1886, p. 719), discussing especially the genus Hyracotherium.

M. Pavlow concludes her review with the following propositions:

1. The Condylarthra is a mixed group, of which the forms present characters of Ungulata and Unguiculata, and that it should be regarded as occupying the base of the genetic tree of both ungulates and carnivores.

2. That *Phenacodus primævus* and *P. puercensis* are probably the ancestors of the Equidæ.

3. That *Phenacodus wortmani* should be excluded from this genus, and with Protogonia, which includes *Hyopsodus paulus* Leidy, should be placed among the Phenacodontidæ.

4. That Anisonchus, Haploconus, and Hemithlæus are rather the ancestors of the Carnivora; that their teeth separate them from other Condylarthra.

5. That Meniscotherium should belong to the group Propalæotheriidæ, and is perhaps synonymous with Propalæotherium.

6. That *Hyracotherium leporinum* should perhaps be regarded as the representative of the Phenacodontidæ in Europe, and that the other species of Hyracotherium should remain at the base of the genealogy of the Equidæ; and that, therefore,

7. The Condylarthra do not represent a group peculiar to America, but have representatives in Europe.

With regard to these conclusions, it may be said that the first and second are in accord with current views on the respective subjects. As regards No. 2, the difference between *Phenacodus wortmani* and the *P. primævus* is not so great as might be supposed from my figure of the superior molar teeth. The anterior intermediate tubercles of the superior molars are present, but, as they are somewhat worn in the specimen, the artist did not represent them nearly distinctly enough. Nothing but the teeth of Hyopsodus are yet known, so that its position is uncertain. It may be a lemuroid or an artiodactyle. (4) The genera mentioned

[1] Cope, Amer. Nat., 1884, 347; Origin of the Fittest, 1886, p. 343. I take occasion to remark that the omission of the Marsupialia from the direct line of phylogeny of the Condylarthra, which is justly commented on by M. Pavlow, is a pure inadvertence, as may be inferred from the text (p. 351). The error is corrected at the second reference.

have the dental characters of other Periptychidæ more or less modified, and, like them, are all constructed on a tritubercular principle. *Haploconus lineatus* is a miniature of *Periptychus rhabdodon.* The approximation of Periptychus to the Suidæ by Pavlow is made apparently in forgetfulness of this fundamental point. (5) Meniscotherium is a well-marked Condylarthron, and its characters show that foot-structures are of greater importance than those of the teeth. The latter resemble those of Pachynolophus (Propalæotherium), but the feet of the latter are unknown, and from its higher geological position it is likely to be a Perissodactyle, as it has been hitherto regarded. (6) M. Pavlow thinks that the *Hyracotherium leporinum* Owen (type of the genus) belongs to the Condylarthra. But Owen and Cope have shown close allies (one of which, *Pliolophus vulpiceps,* is thought by Lydekker to be identical with it) to be undoubted Perissodactyla. I refer here to the fact that Schlosser regards Hyracotherium as one of the Equine family, because the inner anterior cusp of the lower molars is double, forming the basis of the two cones, etc., in the same position in Anchitherium and the rest of the horse line. I wish to repeat here what I have already stated,[1] that this character *does not exist* in the American species, and is probably wanting in the *H. leporinum.*[2] It exists in some of the American species of Pliolophus, but I do not regard it as a constant character[3] in these animals. Both Kowalevsky and Pavlow think the *H. siderolititum,* in which this character is present, should be placed in a genus distinct from the type *H. leporinum.* It is extremely different from that species in the well-developed anterior V of the inferior molars, as well as in the double anterior inner cusp. But in the American species there is every transition between the rudimental hook of the *H. craspedotum* to a V almost as well developed as in the *H. siderolititum.* For these and other reasons I have regarded the Hyracotheriidæ as a variable family, and as the ancestors of *all* the Perissodactyla, of both the equine and tapiroid lines and others. Hence M. Schlosser may perceive the reason why I derive Lambdotherium from Hyracotherium.[4] (7) The existence of Condylarthra in Europe is to be expected. The order may have been of wide distribution in the Northern and possibly in the Southern Hemisphere, but we have as yet no evidence of its existence out of North America.—*E. D. Cope.*

Geological News.—GENERAL.—Dr. J. Walther (*Jenaische Zeitschrift,* 1887) publishes, as the result of his investigations upon the structure of the flexures on the borders of continents, the following conclusions: "The continents are generally sur-

[1] Naturalist, 1886, August, p. 720.
[2] Kowalevsky, Palæontographica, 1873 (Anthracotherium), pl. viii., f. 5–7.
[3] *Pliolophus vintanus,—e.g.,* Expl. S. W. 100th Mer., xlv. f. 12.
[4] Morphologisches Jahrbuch, 1886–87, p. 576.

rounded by flexures, and the course of the so-called hundred-fathom line corresponds to the descending limb of the anticlinal backbone. The region within the hundred-fathom line is composed of the edges of the beds and the rocks lying on them, and does not belong to the ocean-basins, but to the continent." The varying width of the region within the hundred-fathom line depends upon the nature of the coast and the action of the currents; thus, when a current meets a peninsula the lee side gets more transported material than the side towards which the current is turned, but under other conditions this is reversed. Barrier-reefs, says our authority, always stand upon a continental border composed of rock fragments, and the want of such a border upon the west coast of tropical America explains the absence of a barrier-reef. Coast-volcanoes mark regions of subsidence; in such regions there is a synclinal arrangement of the materials thrown up, and coast-volcanoes outside of the hundred-fathom line stand on the synclinal.

CAMBRIAN.—Dr. G. Bornemann has recently described the fossils of the Cambrian of Sardinia. Many of the forms are closely similar to those recorded by Billings from the calciferous rocks of the Mingan Islands and other localities bordering on the St. Lawrence. *Archæocyathus* Bill. is very abundant. This fossil has also lately been discovered in the Durness limestones of Scotland.

PERMIAN.—Professor Credner has recently published the results of his studies of the life-history of a Labyrinthodont, or Stegocephalian, from the "Rothliegendes" of Saxony. The species studied was that described by Credner as *Branchiosaurus amblystomus*, and by Gaudry as *Protriton petrolei.* As no less than seventy-six examples were studied, a good idea of the life-course of the creature was obtained, and it was found that in its early stages it was aquatic, breathing by gills supported by four pairs of branchial arches. By the time Protriton reached a length of 60 to 70 mm. it cast its branchiæ and became an air-breather, its development being somewhat analogous to that of the Salamandridæ of the present day. The adults measure from 100 to 130 mm. in length. During the metamorphosis many changes occur in the skeleton, the skull becomes narrower, the interclavicle increases greatly, and the pelvis shifts backwards so that six of the caudal vertebræ become lumbar.

Professor Fritsch, of Prague, has discovered a species of theromorphous reptile of the genus Naosaurus in the Permian beds of Bohemia. This genus has been found hitherto only in Texas, and was described in this journal, 1886.

TRIAS.—Professor Cope has presented to the American Philosophical Society a description and figure of the cast of the brain-

case of *Belodon buceros*. Although there is no parietal foramen of the skull, the epiphysis is so enormous as to lead to the belief that the pineal eye was present. It had communication with the orbit by a canal on each side, which Professor Cope calls the *orbitopineal* canal.

TERTIARY.—Lydekker recently described *Scelidotherium chilense*, from Tarapaca, Chili. It is characterized by extremely short nasals. He also described as new *S. bravardi*, from the Argentine Republic, a form which had previously been included by Owen with the typical *S. leptocephalum*.

POSTPLIOCENE.—The discovery at Spy, in the Belgian province of Namur, of remains of two human individuals allied to those before found at Canstadt and Neanderthal, has proved that this type of man is that of a race which lived in the age of the mammoth, the bones of which, along with those of the rhinoceros, hyæna, cave-lion and cave-bear, etc., were also found in the Spy cavern. The two skulls serve as a sort of link between the Neanderthal skull and others of the same type, which can thus be traced from Stængenes, in Scandinavia, to Olmo, in Italy. The men of Spy are described by M. Fraipont, who has made an exhaustive study of the remains, as a short, but thick-set, robust folk, walking knees foremost and bandy-legged, like the modern Lapps. The broad shoulders carried a long, narrow, and depressed head, with very prominent superciliary arches, high cheek-bones, enormous orbits, retreating brow, and receding chin,—a combination of characters not to be found in any living race, and in many points showing apian affinities.

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—In the August number of the *Geological Magazine* Mr. J. J. H. Teall[2] describes an interesting suite of hornblende rocks which occur as intrusive sheets and bosses in the limestones and quartzites of the Assynt district in Scotland. From the description which the author gives of them, these rocks appear to be somewhat similar to the camptonite of Dr. Hawes.[3] Three types are distinguished,—viz., hornblende porphyrites, diorites, and porphyrite diorites. In the last two classes hornblende is abundant in well-formed porphyritic crystals, bounded by the planes ∞P, $\infty P\grave{\infty}$, $-P$ and oP. Some of the larger of these crystals are so perfectly developed that when separated from the surrounding rock-mass their angles can be measured with a contact goniometer. Most of them are twinned according to the ordinary law, and many present fine instances of zonal

[1] Edited by Dr. W. S. BAYLEY, Madison, Wisconsin.

[2] Geol. Magazine, August, 1886, p. 346.

[3] Lithology of New Hampshire, p. 160, *et seq.*; Rosenbusch's Massige Gesteine, 1886, p. 333.

growths. In the hornblende porphyrites the hornblende crystals are less abundant. This class is characterized by the presence of feldspar in two generations. The porphyritic crystals are sharply outlined, and are developed in thick tables parallel to the clinopinacoid. They often show zonal banding, due to the variations in the optical characteristics of successive layers. The feldspar of the second consolidation occurs in grains, often forming the greater part of the ground-mass in which the crystals of hornblende and feldspar are found. In addition to these minerals, a very light-colored pyroxene is present in those sheets which are intrusive between limestone.——The same author[1] mentions another instance of the development in eruptive rocks of a schistose structure, accompanied, at the same time, by a change in mineralogical composition.[2] The normal gabbro of the Lizard peninsula in Cornwall is intrusive in serpentine and other rocks, and is itself penetrated by dykes of epidiorite. It is composed of diallage, hornblende, and saussuritized plagioclase, with here and there a little fresh olivine. The hornblende is secondary and of three varieties,—a compact brown, a uralitic, and an actinolitic variety. The saussuritization of the plagioclase and the alteration of the original augite into hornblende appear to increase as the pressure to which the rock-mass was subjected is seen to have been greater. Generally, though not always, the alteration in the composition of the rock is accompanied by a change in its structure. The massive character of the normal rock is lost, and a secondary schistose structure takes its place. These schistose rocks the author calls flaser-gabbros, augen-gabbros, and gabbro-schists. In the first the parallel arrangement of the constituents is distinct, but not so marked as to give rise to that perfect fissility characteristic of the third class. The augen-gabbros are similar in structure to the well-known augen-gneisses. These different types of structure, as well as the alteration in the original composition of the rock, the author regards as results of the action of pressure, which in some cases was so great as to give rise to faults.——The hyperesthene crystals from the hyperesthene andesite of Pokhausz, Hungary, have been isolated and examined by A. Schmidt.[3] The rock in which they occur consists of a dark gray isotropic ground-mass, in which the hyperesthene and plagioclase are scattered in porphyritic crystals. The grass-green augite of the amphibole-andesite from near Kremnitz has likewise been isolated and examined.——The igneous rocks of the Warwickshire coal-field, according to Professor Rutley,[4] are syenites, andesites (English), quartzites, diorites (both augitic and olivenitic), and tufas.

[1] Geol. Magazine, November, 1886, p. 481.
[2] *Cf.* American Naturalist, December, 1886, p. 1049.
[3] Zeits. f. Krystall., xii. p. 97.
[4] Geol. Magazine, December, 1886, p. 557.

Mineralogical News.—In 1871, Tschermak discovered that the optical characteristics of the various pyroxenes depended in great measure upon the proportion of their iron constituent. He found that with increase of iron there was a corresponding increase in the size of the optical angle, and also in the inclination of the acute bisectrix to the vertical axis of the monoclinic varieties. In later years Wiik, Herwig, and Doelter examined monoclinic pyroxenes with the view of deciding as to whether Tschermak's observations would be found to apply generally. Their results, however, were not conclusive. Very recently G. Flink[1] of Stockholm, declares, as the result of investigations made on *diopside*, *schefferite*, and *rhodonite*, that the crystallographic angle β varies with variation in the percentage of iron, increasing with the increase of this constituent and decreasing with its decrease, but within very small limits (22′). The morphotropic action of manganese is to diminish the size of the angle and to carry the crystallization of the pyroxene over to the triclinic system. The value of this angle for different proportions of manganese is given as follows:

Diopside (Mn = free).	Schefferite (MnO = 8.32 %).	Rhodonite (MnO = 41.88 %).
74° 11′	73° 53′	71° 15¾′

The optical angle and the angle of extinction in the plane of symmetry both increase with the rise in the percentage either of iron or manganese. The geometrical, optical, and chemical properties seem to show that the diopsides among the pyroxenes form a continuous series analagous to the plagioclase series among the feldspars.——In the course of the above investigation Flink had occasion to work over a large series of diopside, schefferite, and rhodonite crystals, the results of which he incorporates in his paper. On *diopside* from Nordmark, Sweden, he finds the following new forms: $\infty P\bar{5}$, $\infty P\bar{7}$, $\frac{4}{3}P\bar{\infty}$, $-2P\dot{\bar{\infty}}$, $-\frac{1}{9}P$ and $\frac{1}{5}P\grave{\infty}$. *Schefferite* is the name given by Mikaelson to a manganese-rich diopside from Långban. According to Flink its composition is:

SiO_2	CaO	MgO	MnO	FeO
52.28	19.62	15.17	8.32	3.83

It crystallizes in red, brown, or black crystals bounded by the planes oP, P, $P\bar{\infty}$, 2P, $\infty P\bar{0}$, ∞P, and —P. The habit of these is determined by the greater or less development of the three planes oP, $P\bar{\infty}$, and P. Twins are very common according to the ordinary law of the pyroxenes. The axial ratio is: a : b : c = 1.1006 : 1 : 0.59264. $\beta = 73° 53′$. In thin section the mineral is almost colorless. It possesses very weak pleochroism. It extinguishes 44° 25½′ in the clinopinacoidal section, is positive and $2Va = 65° 3′$ for yellow light. *Rhodonite* usually occurs massive. But few fine crystals have heretofore been described. In the article under

[1] Zeitschrift f. Kryst., xi. p. 449.

discussion Flink mentions the fact that he has become possessed of a large collection of good crystals from Pajsberg and Långban. These he examines, and finds on them nineteen forms new to the species. The axial ratio as calculated from his measurement is: $a : b : c = 1.0727 : 1 : 0.52104$. The inclinations of the axes to each other are $\alpha = 76° \ 41' \ 52''$, $\beta = 71° \ 15' \ 15''$, $\gamma = 81° \ 39' \ 16''$. The plane of the optical axes is inclined to $0P$ and $\infty'P$ at 63° and 38½° respectively. It corresponds to $\frac{3}{2},P\underline{16}$, $\frac{2}{3},P\overline{16}$. The acute bisectrix is perpendicular to the plane $\frac{5}{3}P\overline{17}$ and is probably negative. $2Va = 76° \ 12'$ for sodium light and $\rho < \upsilon$ absorption $\mathfrak{b} > \mathfrak{a} > \mathfrak{c}$—. The intergrowth of minerals of analogous composition has within the past few years been proven to be very much more common than was formerly supposed. The microscope has revealed the fact that very many rock-forming minerals, as, for instance, the pyroxenes and the feldspars, very frequently occur intergrown with lamellæ of analogous but slightly different composition. The method of etched figures has shown the same statements to hold good in regard to minerals which occur only in massive form. By the latter means Baumhauer[1] has succeeded in detecting irregular intergrowth of various substances in *cloanthite* and *smaltite*. The occurrence of thin lamellæ of *ilmenite* in crystals of *magnetite* from the chlorite-schist of Greiner in the Zillerthal, is placed beyond doubt by the separation and analysis of the two components of these crystals by Cathrein.[2] ——Little *bournonite*[3] crystals cover the cubic faces of galena from Příbram. Their long axes are either parallel to the combination edge between $\infty O \infty$ and O, or they are inclined to this at an angle of 45°.

Crystallographic News.—The twinning law of *lepidolite*[4] from Schüttenhofen, in Bohemia, is the same as that for the more common micas,—*i.e.*, the twinning plane is ∞P. The dispersion of the axes is very similar to that in the hemihedral crystals of the orthorhombic system. Intergrowths of muscovite and lepidolite take place parallel to the twinning position of micas of the same composition.——Several brief communications on the crystallography of *topaz* have lately appeared. In one H. Bücking[5] discusses the forms appearing in the topaz of Mexico, with reference more particularly to the Durango crystals.[6] A large number of new planes have been detected. A second article, by Fr. Feist,[7] describes a crystal of topaz from the Ilmengebirge.

The *Zeitschrift für Krystallographie* for the past few months has contained quite a number of short articles descriptive of single

[1] Zeits. f. Kryst., xii. p. 18.
[2] Ib., p. 40.
[3] C. Hintze, Ib., xi. p. 606.
[4] R. Scharizer, ib., xii. p. 1.
[5] Ib., pp. 424 and 451.
[6] *Cf.* also Des Cloizeaux, Bull. d. l. Soc. franç. de Min., 1886, p. 135.
[7] Zeits. f. Kryst., xii. p. 434.

crystals of different minerals from various localities. Gehmacher[1] gives a series of measurements on the faces of colorless *zircon* crystals from the Pfitschgrund, in the Tyrol.——The axial ratio of *datholite* from the Seisser Alps, as calculated by Riechelmann,[2] is $a:b:c = 0.63584:1:0.6329$. The angle $\beta = 89° 54'$.——The new forms $\frac{1}{40}P$, $\frac{1}{28}P$, $\frac{1}{5}P^2$, $\frac{3}{13}P_3$, $\frac{5}{3}P^5$, and $\frac{3}{4}P\frac{9}{4}$ (?) have been added to the list of planes occurring on *anatase* [3] by Seligmann.——The same investigator has measured *pyrrhotite* from the druses of basalt from the Cyclopean Islands. The results indicate that the mineral crystallizes in the hexagonal system with the axial ratio: $1:1:1:1.65022$.——In the same article Seligmann describes a *wolframite* crystal from the Sierra Almagrera in Spain, on which are the two new forms $-2P\bar{2}$ and $-3P\frac{\bar{3}}{2}$. The mineral is monoclinic with the axial angle $\beta = 90° 26'$ and the axial ratio $0.82144:1:0.87111$.——New crystallographic planes have also been discovered by Sansoni[4] on calcite from Blaton, Belgium.——Sansoni[5] also mentions the fact of the tendency in *barite* crystals from Vernasca, Italy, for the prismatic and end faces to converge towards the free end of the axis to which they are parallel, and along which the crystals have their greatest development.

Miscellaneous.—The diamonds found in the African diamond-fields occur[6] in the immediate neighborhood of volcanic pipes cutting carbonaceous strata of Triassic age, and containing as inclusions pieces of the shales forming the greater part of the series, through which they break. The richest yield of the gem is obtained from the outer portion of the pipes, where the included fragments are most abundant. The rock composing the lower portion of the pipes is quite fresh. It is a peridotite of which certain portions are diamantiferous, while other portions contain no diamonds. The diamantiferous variety is crowded with fragments of shale, while the non-diamantiferous variety is free from them. From these and other facts it is concluded that the diamonds are secondary minerals produced by the reaction of the lava (with heat and pressure) on the carbonaceous shales in contact with and enveloped by them. A study of the occurrence of diamonds in other regions seems to indicate the correctness of this conclusion, as Mr. Diller[7] points out the fact that in most American localities where diamonds are known to occur the same relation of carbonaceous shales and very basic eruptive rocks has been observed to exist. Mr. O. A. Derby,[8] on the other hand, does not accept this explanation for the origin of the

[1] Zeits. f. Kryst., xii. p. 50. [2] Ib., p. 436.
[3] Ib., xi. p. 337. [4] Ib., p. 352. [5] Ib., p. 355.
[6] H. C. Lewis, Geol. Magazine, January, 1887, p. 22.
[7] Science, Oct., 1886, p. 392; also Geol. Survey of Kentucky; Report on the Geology of Elliott Co., p. 27.
[8] Science, Jan., 1887, p. 57.

diamonds of the Brazilian fields.——In the lower greensands at Flitwick and Sandy, in Bedfordshire, England, Mr. A. G. Camero[1] has found ironstone nodules filled with water, which they lose by evaporation when left exposed to the action of dry air.

BOTANY.[2]

The Growth of Tulostoma mammosum.—This odd puff-ball, which is found upon a stalk varying from one to five inches in length, occurs in abundance in the vicinity of Lincoln. I have been much interested in watching its development,—a thing by no means as easy as for many other puff-balls. One usually finds it in the Spring, in ground which had been cultivated the previous year. It often grows in clusters or groups of from half a dozen to a dozen or more, and, upon the bare ground, in the early part of the season, just after the disappearance of the snow, they are easily found. In the summer and autumn they are much more difficult to find. Last summer I was fortunate enough to discover a few clusters just as they were developing, and noted some facts which appear to be new. The ball forms under ground, and reaches maturity there,—that is, so far as its spores are concerned. Tulostoma agrees with Lycoperdon in having the interior of the ball composed of two portions,—viz., (1) a spore-bearing part occupying most of the interior, and (2) a sterile base composed of tissue which does not produce spores. Now, in Lycoperdon, if one makes a vertical section of a young ball which has nearly ripened its spores, the two parts may be very easily distinguished. In some species the sterile base is quite small, occurring merely as a greater or less thickening of the boundary tissues at the base of the ball, while in others it is well developed, notably so in *Lycoperdon cœlatum.*

In Tulostoma a portion of the tissue of this sterile base remains living until after the ripening of the spores in the ball. At this time the tissue begins a rapid growth, and, as a consequence, a cylindrical stalk is quickly produced. This forces the ball through the overlying earth, and sometimes carries it up several inches. This sudden formation of the stalk reminds one of the similar growth of the stalk in the Phalloideæ, to which, indeed, as is well known to mycologists, Tulostoma is distantly related.

The stalk of Tulostoma (of this species, at least) never develops while the ball is immature. One never finds young balls upon a stalk. In fact, I have, as yet, not succeeded in finding any balls in which the spores were not well developed. This, of course, is due to their subterranean habit. I doubt not, however, that the details of their early development are essentially like

[1] Geol. Magazine, August, 1886, p. 381.
[2] Edited by Prof. Charles E. Bessey, Lincoln, Nebraska.

those of other puff-balls. Their greatest difference is that just pointed out, whereby the sterile base develops a stalk after the ball has matured its spores.—*Charles E. Bessey.*

Ash-Rust again.—It will be remembered that I called attention, two years ago, to the great abundance of the Ash-Rust (*Æcidium fraxini* Schwein) upon the Green Ash (*Fraxinus viridis*) in Lincoln. Last year I noted the fact that this rust was very rare in the same locality. This year the rust is, if anything, still more rare than last year. I have seen scarcely any leaves affected by it, and have had but few specimens brought to me by a large class of efficient student collectors. It is difficult to suggest an adequate explanation of the sudden disappearance of what threatened in 1885 to be a very serious pest to the Green Ash. The trees were badly affected in 1884 also, as I noticed about the 1st of July, while on a visit of a few days to the city. I have no data earlier than that year. The record thus far is as follows: 1884 and 1885, ash-rust abundant; 1886 and 1887, ash-rust rare.—*Charles E. Bessey.*

Vitality of Buried Seeds.—On May 25, 1886, I buried the following seeds five feet deep in light, sandy soil, at Grand Rapids, Mich.: white oats, common white beans, Stowell's evergreen sweet-corn, Hathaway dent-corn, and buckwheat. All were grown in 1885, and had percentages of germination in good, sandy garden-soil varying from 87 to 94. One hundred seeds of each were mixed with sand and placed in separate, open, tin cans, with the openings downward. On May 22 of this year (1887) I had them examined. All were dead. A little of the sweet-corn had sprouted; most of the dent-corn had grown about three inches in length, having roots that filled the can. The other seeds had decayed without germinating.—*A. A. Crozier, Department of Agriculture, Washington, D. C.,* June 3, 1887.

The Study of Lichens.—"To the American student the study of lichens presents peculiar difficulties. Some of these are (1) the want of any work containing the descriptions of all known lichens; (2) the difficulty of procuring the works upon lichens, and the fact that they are mostly in foreign languages,—Latin, German, French, etc.,—and that many useful works are published in the proceedings of learned societies, and are not to be consulted here; (3) the embarrassment arising from the multiplicity of systems, and the differences of opinion as to the limits of genera and species; (4) the vast synonymy, which renders it often difficult to decide as to the proper name of a plant; (5) the extent and variety of our own lichen-flora, and the incompleteness of the work of our great authority, Tuckerman."

The foregoing quotation is from an interesting little work, entitled "An Introduction to the Study of Lichens," by Henry Willey, of New Bedford, Mass., which is intended to help the beginner over some of the above-mentioned difficulties, as well as to lay a broad foundation for good work. Five pages of the book are devoted to the collecting and preservation of lichens. Ten pages are given to the structure and organs of lichens; two and a half to the distribution of North American lichens; four to the history of lichens; two to bibliography; and twenty-eight to their systematic arrangement. The ten plates which are added will be very helpful to the student.

A slip of the pen, which can easily be corrected, occurs on page 11, where a lichen is said to be "a cryptogamic plant of the order [*sic*] Thallophytes." Class, or Branch, was evidently intended. In the fifth chapter it would have been well, perhaps, to have referred to a distribution of sets of New England lichens begun eight or ten years ago by Dr. Halsted, but soon abandoned. Reference should also have been made to the excellent introduction to the study of the structure and development of lichens in Sach's "Text-Book of Botany," Goebel's "Classification of Plants," and the article "Lichens," by the Rev. James M. Crombie, in the fourteenth volume of the ninth edition of the "Encyclopædia Britannica."

Cannot the botanists of the country prevail upon Mr. Willey to undertake the task of preparing sets of North American lichens? There can be little doubt as to the success of such an undertaking.—*Charles E. Bessey.*

Botanical News.—The "List of Works on North American Fungi," published in the *Harvard University Bulletin*, No. 37, by Professors Farlow and Trelease, is a most valuable aid to the student of the fungi. The list extends from A to H, and already includes three hundred and thirty-eight entries. The remainder is promised soon.——A book which will prove useful in the herbarium is announced by Merzbach & Falk, Rue des Paroissiens, 18, 20, 22, Brussels. It bears the title of "Index Generum Phanerogamorum," and will form an octavo volume of about six hundred and fifty pages. The subscription-price is twenty francs.——A new journal, the *Annals of Botany*, is announced in England. It "will resemble the well-known *Quarterly Journal of Microscopical Science*," and will be printed and published by the Clarendon Press, Oxford. Many eminent English botanists have given the project their support, and in this country the names of Professors Gray and Farlow appear as promising their support. The subscription-price will be twenty-one shillings per volume.——From the *Bulletin of the California Academy of Sciences* we have a paper by Dr. C. C. Parry on the Pacific Coast Alders, and one by Professor E. L.

Greene, entitled "Studies in the Botany of California and Parts Adjacent."——Dr. Halsted's *Bulletin of the Iowa Agricultural College*, from the Botanical Department, contains many things of interest, from methods of work and study in the class-room and laboratory to scientific descriptions of species.——Dr. Vasey has recently issued a pamphlet of sixty-three pages on the "Grasses of the South." It forms Bulletin No. 3 of the Botanical Division of the Department of Agriculture at Washington. Aside from its high value to the agriculturists of the South, it possesses a good deal of botanical interest.——The weeds of Southwestern Wisconsin have been listed and discussed by L. H. Pammel in a twenty-page pamphlet, which has just appeared.

ZOOLOGY.

Radiolaria.—By far the most important contribution to our knowledge of the Protozoa within recent years is the report on the Radiolaria of the "Challenger" expedition, just published by Professor Ernst Haeckel, of Jena. A summary of these nearly two thousand pages and one hundred and forty quarto plates is impossible. We can but indicate something of their scope. Professor Haeckel now restricts the limits of the Radiolaria more than formerly. As he now defines them they are "Rhizopoda with central capsule and calymma," for, as he says, their most important character is the fact that the unicellular body is always in two main portions, an inner central nucleated capsular and an extracapsular non-nucleated portion, the calymma, the two being separated by a capsule-membrane. The majority have a skeleton, usually of silica, but frequently of organic substance (acanthin), and this may take the most beautiful shapes imaginable. The present report embraces not only the Radiolaria taken by the "Challenger" collections, but is a complete monograph of all known species, and has employed Professor Haeckel's time for ten years. The classification now adopted varies considerably from that of his monograph "Die Radiolarien" of 1862. It divides the group or class into two sub-classes.

Sub-Class I.—Porulosa. Central capsule primitively a sphere, and retains this homaxon form in the majority of species. The membrane of the central capsule is everywhere perforate, but possesses no larger osculum. The pseudopodia radiate in all directions, and in great numbers, passing through the openings in the capsular membrane. To this sub-class belong two legions,—1, Peripylea, or Spumellaria, with six orders, and, 2, Actipylea, or Acantharia, with four orders.

Sub-Class II.—Osculosa. Central capsule originally monaxon (ovoid or spheroidal), retaining this condition in most species. The membrane of central capsule with a single large osculum at the base of its vertical main axis. Pseudopodia radiating from the sarcode streaming from the osculum. This also contains

two legions,—1, Monopylea, or Nassellaria, with six orders, and, 2, Cannopylea, or Phæodaria, with four orders.

The immense amount contained in this work can be readily seen from the fact that these twenty orders are in turn subdivided into eighty-five families, seven hundred and thirty-nine genera, and four thousand three hundred and eighteen species; but large as these numbers are, Professor Haeckel doubts if they include half of the recent species. The ancestral group from which all the others are probably derived is the spherical Actissa, the most ancient stem form of the Spumellaria. The literature of the Radiolaria is not very extensive, only sixty titles being catalogued from 1834 until the present date. In the bibliography is a "Phaulographic Appendix," a division which embraces "absolutely worthless literature," a feature which might well be adopted in other bibliographies. The beautiful plates which illustrate the volume show what a field there is in these minute forms for the artist.

Ctenodrilus parvulus.—Under this name Dr. Robert Scharf describes[1] a new species of Oligochæte worm, probably from some part of the British coast, though the exact locality is unknown. The species differs from the two species (*Ct. pardalis* and *Ct. monostylos*) in its smaller size, having but from seven to ten segments, and a total length of about 4 mm. It has but one kind of setæ, which are not pectinated, and it differs from *monostylos* further in lacking the peculiar tentacle found in that form. Scharf concludes that the number of setæ in a bunch is not a good diagnostic character. There is but a single pair of nephridia, which lie in the head. As in the other species the nervous system lies entirely in the ectoderm, and in some regions it is difficult to say where epidermal cells end and nerve-cells begin. No traces of reproductive organs were found, the only mode of reproduction being that by fission, which took place much as described by Kennel in *Ct. pardalis.* A bud is formed between two segments, and, in contradistinction to the Naidæ, these buds are formed in the same order that the new segments are formed, —*i.e.*, from in front backward. The first three segments never show any signs of budding, nor do the last two or three. The buds appear on the anterior dorsal margin of each segment, the segmentation of the body becomes deeper, and soon the body divides, the resulting portions developing the parts necessary to make them perfect worms. The process occupies about forty-eight hours.

Balanoglossus Larvæ.—Mr. W. F. R. Weldon gives a preliminary account of two Balanoglossus larvæ (*Proc. Roy. Socy.*, No. 253) which he obtained in the Bahamas, and which differ

[1] Quarterly Jour. Micros. Sci., xxvii., March, 1887.

considerably in their later development from those described by Bateson (*vide* AM. NAT.). The earliest stage had but a single transverse groove, but the later stages seem readily homologous with Bateson's form up to the time of the appearance of a pair of rudimentary gills. From this point the majority of the specimens undergo a gradual process of degeneration, accompanied by considerable increase in size. The proboscis itself becomes grooved on either side, each groove being provided with short, broad tentacles, while the circular post-proboscidean groove nearly disappears. Internal changes also occur, involving the disappearance of both notched and gill cavities, and an extensive degeneration occurs in the nervous system. The conclusions drawn are, "that there is fair ground for the belief that the organisms described are Balanoglossus larvæ, which for some cause or other have been unable to develop adult characters, and have therefore varied," a probable cause being the drifting of the larvæ into deep water by the action of currents and winds. If this be true, it follows: 1, that in some cases at least heredity can work only on the application of stimuli afforded by particular surroundings; 2, that some larvæ without stimuli are highly variable; 3, that variations produced by a given change may be uniform and definite in character; and, 4, these changes may produce not the modification of ancestral characters, but a hypertrophy of those which are purely larval.

The Glands in the Foot of Nudibranch Molluscs.—Dr. J. H. List gives the result of his studies of the foot of *Tethys fimbriata* (*Zeit. wiss. Zool.*, xlv.). After a few remarks upon the histological structure of connective tissue, muscles, and epidermis, he gives a detailed account of the glands. He recognizes in the upper surface, 1, unicellular mucous glands; 2, unicellular glands with fat-like contents (phosphorescent in function?); 3, unicellular glands with peculiar, frequently laminated contents; and, 4, unicellular glands with coarsely granular contents. On the under surface occur, besides beaker-cells and Nos. 1, 2, and 4 of the upper surface, polynuclear glands, resembling those described by Leydig as pigment and calcareous glands in the feet of terrestrial gasteropods. As in those cases, these latter glands are connected with the connective-tissue cells. Here, however, they contain neither pigment nor lime.

Fresh-Water Crustacea.—Mention should have been made before of Professor L. M. Underwood's "List of the Described Species of Fresh-Water Crustacea from America, north of Mexico," which appears in the second volume of the *Bulletin of the Illinois State Laboratory of Natural History*. It is more than its name implies, for it includes the Oniscidæ, which are terrestrial, as well. The total number of species enumerated is nominally

three hundred and thirteen, but doubtless many of these will be found to be synonymes, while there are some omissions to be expected in the pages. A tolerably complete bibliography completes the article. At a casual glance, however, the following titles are noted as not occurring in the list, and are mentioned here so as to make it more complete. All have references to terrestrial or fresh-water forms in the region embraced in the original paper:

Abbott, C. C., "Notes on the Habits of Certain Crawfish," AM. NAT., vii., 1873.

Cooper, J. G., "Report on the Crustacea," "Pacific R. R. Survey," vol. xii., pt. ii., 1860.

Faxon, W., "On the so-called Dimorphism in the Genus Cambarus," *Am. Jour. Sci.*, January, 1878.

Haldeman, S. S., "Crustacea in Baird's Translation of Hoeck's Iconographic Encyclopædia."

Harford, W. G. W., "Description of a New Genus and Three New Species of Sessile-Eyed Crustacea," *Proc. Cal. Acad.*, vii., 1876.

Hay, O. P., "Description of a New Species of Crangonyx." Printed for the author, June 2, 1878.

Harlan, Richard, "Description of a New Species of the Genus Astacus," *Am. Phil. Trans.*, n. s., i., 1830.

Herrick, C. L., "Habits of Fresh-Water Crustacea," AM. NAT., October, 1882.

Herrick, C. L., "Types of Animal Life, Pt. I., Arthropoda." Minneapolis, 1883.

Ingersoll, Ernst, in "Annual Report U. S. Geol. Geog. Survey of Territories for 1874," pp. 387, 388.

Kingsley, J. S., "Synopsis of North American Species of Alpheus," *Bulletin U. S. Geol. Survey*, vol. iv.

Kingsley, J. S., "Carcinological Notes, V.," *Bulletin Essex Inst.*, xiv. p. 105.

Lockington, W. N., "Thalassinidæa and Astacidea of the Pacific Coast," *Annals and Mag. Nat. Hist.*, October, 1878.

Lamarck, P., "Hist. Nat. Animaux sans Vertèbres."

Packard, A. S., "Structure of the Brain of Sessile-Eyed Crustacea," "Memoirs Nat. Acad. Sci.," iii.

Rathbun, R., "Shrimp and Prawn Fisheries of the U. S.," *Bulletin Fish Commission*, 1882.

Rathbun, R., "Collection of Economic Crustaceans, etc., at Fisheries Exhibition, Washington, 1883."

Ryder, J. A., "Successive Appearance of Chirocephalus and Streptocephalus," AM. NAT., p. 703, 1879.

Stuxberg, A., "Tvenña nya Oniscider," *Ofversigt. Vet. Akad. Forh.*, Stockholm, 1872, No. 9.

Dr. O. E. Imhof, after a careful collection of the microscopic fauna of the Alpine lakes of Europe, states that the great ma-

jority of the fresh-water basins up to two thousand metres harbor a pelagic fauna very rich in individuals. Some of the lakes at higher elevations are also well supplied. From seven to sixteen species appear usually in each lake up to seventeen hundred and ninety-six metres. The most widely and generally distributed genera are Daphnia, Cyclops, and Diaptomus.

Tropidonotus clarkii B. G., in Southern Louisiana.—Early in June, 1886, the writer had occasion to collect on the salt marshes at Grand Isle, Louisiana. This island is on the Gulf coast at the entrance of Barataria Bay, about forty miles west of the mouth of the Mississippi. Here Clark's water-snake (*Tropidonotus clarkii*) was not uncommon, as several were seen daily, and one or two were secured for identification.—*A. K. Fisher, M.D., Washington, D. C.*, June 7, 1887.

Spelerpes guttolineatus Holbrook, in the Vicinity of Washington, D. C.—On April 10, 1887, Mr. H. W. Henshaw and the writer spent the greater part of the day collecting in the vicinity of Munson Hill, Va., a locality not more than five or six miles in an air-line from the city of Washington.

The surface of the country is very much broken by numerous hills and valleys. The hills and ridges are covered for the most part with pines, while the valleys support a growth of deciduous trees, many of which are of large size.

In a spring at the edge of one of the principal valleys, we were fortunate enough to capture two specimens of *Spelerpes guttolineatus*. According to Professor Cope, who kindly examined the specimens, this locality is several hundred miles north of the known range of the species.

The following species were also found in the same spring: *Spelerpes bilineatus*, *Spelerpes ruber*, *Plethodon erythronotus*, and *Desmognathus fusca.*—*A. K. Fisher, M.D., Washington, D. C.*, June 7, 1887.

Muhlenberg's Tortoise (Chelopus muhlenbergii Schweigger), at Lake George, N. Y.—At Lake George, during the summer of 1883, frequent excursions were made across a large Sphagnum marsh, located at the head of Dunham's Bay, and covering several hundred acres.

On nearly every trip the shells of one or more Muhlenberg's turtles were found. It is difficult to reach any satisfactory conclusion as to the cause of death of these turtles, as the shells were not mutilated in the least, though the flesh had evidently been eaten by something.

The occurrence of this southern species in this locality is especially interesting when taken in connection with the presence of such birds as the Large-billed Water-thrush (*Seiurus motacilla*)

and Dove (*Zenaidura macrura*), and of such southern trees as the Dogwood (*Cornus florida*) and Sour-gum (*Nyssa multiflora*), for it tends to show how decidedly this low valley differs from the immediately adjoining border of the Adirondacks region in being Carolinian in its fauna and flora (as already pointed out by Dr. Merriam, "Mammals of the Adirondacks," pp. 11, 12).—*A. K. Fisher, M.D., Washington, D. C.*, June 7, 1887.

Zoological News.—CŒLENTERATES.—Fewkes has described a new medusa from New Haven, under the name *Nectopilema verrillii.* This jelly-fish belongs to the Pilemidæ, and its nearest relatives are Pilema and Rhopilema, with affinities pointing towards Polyrhiza. It is about eighteen inches in diameter, rich, deep brown in the oval cylinder and frills, the umbrella translucent bluish-white.

CRUSTACEA.—H. L. Osborn begins in the May number of the *Amer. Mo. Micros. Jour.* a series of articles on the histology of the crayfish, the first dealing with the green gland.

At a recent meeting of the Linnæan Society of London, Mr. A. O. Walker gave an account of a large collection of Crustacea obtained at Singapore during the years 1879–1883. Several new species of Decapods are described.

Professor H. L. Osborn's article on the Osphradium of Crepidula, to which reference was recently made, has been reprinted in the *Amer. Mo. Micros. Jour.*, viii., pp. 60–64, with illustrations which render the description more readily followed.

WORMS.—Messrs. Gibson and Chalmers, of Liverpool, have come to the conclusion that the so-called hepatic cells of Lumbricus are digestive glands rather than "vasifactive tissue," as has been suggested.

FISHES.—From the Andes of the United States of Colombia G. A. Boulenger describes three new Siluroid fishes.

C. H. Eigenmann and Jennie E. Honing, in their review of the Chætodontidæ of North America, published in the *Annals and Magazine of the New York Academy of Sciences*, admit three genera—Prognathodes, Chætodon, Pomacanthus—and fourteen species of the family.

REPTILIA AND BATRACHIA.—G. A. Boulenger has recently described a new frog of the genus Megalophrys (*M. feæ*), a single specimen of which was procured east of Bhamò, Burma. The head is enormous, nearly twice as broad as long. There are now four species in the genus.

G. A. Boulenger's synopsis of South African snakes contains fifty species, including six Typhlopidæ, only one Python, twenty-six Coluebridæ, ten Elapidæ, and seven Viperids.

G. A. Boulenger has recently described, in the *Ann. and Mag.*

Nat. Hist., a new Rana, three Bufos, and *Phrynella pulchra*, all from Malacca.

MAMMALS.—According to Dr. J. B. Sutton, animals are not free from certain diseases thought to be referable in man to his erect position. One-fourth of the female monkeys dying in the London Zoological Gardens have displacement of the uterus, and the same disease occurs in the lioness, tapir, Cape hunting-dog, pygmy hog, antelope, etc., and in domesticated mammals. Two cases of inguinal hernia in monkeys are recorded, and the disease is said to be common in horses.—*P. Z. S.*, April, 1886.

Balænoptera borealis, or Rudolphi's Rorqual, the "Sejhval" of the Norwegian whalers, proves to be a sufficiently common species, though scarcely known before 1882. In 1885, most of the whales caught along the Finmark coast were of this species. Its average length is about forty-four feet. It is less robust than *B. rostrata*, and may be recognized in the sea by its high, black dorsal fin, more slender head, and more rounded snout. The color is dark gray-blue, except that the belly is more or less white as far as the genitalia. Both sexes seem to attain about the same size; if there is any difference it is in favor of the female. The flippers are slender and pointed, and relatively shorter than in any other species. A new species of Echinorhynchus (*E. ruber*) usually infests the intestines in great numbers, the copepod (*Balænopterus unisetus*) occasionally infests the baleen-plates, and a true ecto-parasite (undescribed) is also occasional. The stomachs of the specimens examined were filled with the remains of the copepod *Colarius finmarchicus*.

The species of Capra, according to Mr. P. L. Sclater, are confined to the following localities: *C. pyrenaica*, to the Pyrenees, Central Spain, and the higher ranges of Andalusia and Portugal; *C. ibex* (the Steinbok), to the Alps of Switzerland, Savoy, and the Tyrol; *C. ægagrus* (the Wild Goat), to Crete and some of the Cyclades in Europe, and through the mountains of Asia Minor and Persia to Sind and Baluchistan; *C. pallasi*, to the Caucasus; *C. sinaitica*, to the mountains of Upper Egypt, the Sinaitic peninsula, and Palestine; *C. walie*, to Abyssinia; *C. sibirica*, to the Altai and the Himalayas; *C. falconeri* (the Markhoor), from the Pirpanjal range, south of Cashmere, into Afghanistan and Gilgit on one side, and the Sulemani range on the other; *C. jemlandica* (the Tahr), to the Himalayas, from Cashmere to Bhotan; and *C. hylocrius*, to the Neilgherries, Anamallays, and other ranges of Southern India.

EMBRYOLOGY.[1]

The Development of Spiders.—The Arachnids are receiving considerable attention recently at the hands of embryologists.

[1] Edited by Prof. JOHN A. RYDER, Biological Department, University of Pennsylvania, Philadelphia.

The latest paper to be recorded is that of Schimkewitsch,[1] on the development of several species of spiders, the main features of which were outlined in a preliminary paper in the *Zoologischer Anzeiger* for 1884. After describing the envelopes of the egg and the composition of the yelk (of which he recognizes three kinds), he proceeds to the segmentation. In this he is inclined to follow Ludwig rather than other observers in the recognition of a central segmentation and a migration of some of the cells to the surface to form the blastoderm, while others remain behind in the yelk, where, in the shape of polynuclear yelk-masses, they represent and finally result in the endoderm. After the formation of the blastoderm, three processes occur nearly simultaneously,—the breaking down of the yelk-pyramids, the concentration of the primary ectoderm, and the formation of the mesoderm, these being individual variations in the species studied. The concentration of the primary ectoderm consists in a flattening and consequent expansion of the cells on one side of the yelk, while on the other they become thicker and more cylindrical, thus giving rise to the germinal area. Although Schimkewitsch appears to be unaware of this fact, this process is paralleled in many Arthropods, and was commented upon at some length by Mayer (*Jenaische Zeitschrift*, xi., 1877). According to Schimkewitsch, the mesoderm arises, in some species, from the blastoderm, in others by budding from the entoderm. His figures, however, all seem reconcilable with the view that they all arise from the blastoderm. The primitive cumulus is, according to Schimkewitsch, the anal lobe, while the "white spot" of the "comet-stage" forms the cephalic lobes,—conclusions somewhat at variance with those of Morin[2] and Locy, the latter reversing the ends of the embryo.

The account of the external development adds but little to our previous knowledge, the principal points being that the mandibular segment is budded from the cephalic one, that Croneberg's antennæ are the rudiments of the upper lip, and that no appendages are developed at any stage upon the first abdominal segment.

In the internal development there are more points to be noticed. The splitting of the mesoderm begins in the fifth segment of the body. At first the resulting cœlomatic cavities are distinct, but soon they run together in the thoracic segments. At about this stage begins the formation of a secondary entoderm, composed of cells budded from the polynuclear yelk-masses, and taking a peripheral position in the yelk. These, thinks Schimkewitsch, may possibly be the yelk-mesoderm of Balfour; but our author does not make it clear how they then pass through the splanchnopleure and take a position in the body

[1] Archives de Biologie, vi. pp. 515–584, pls. xviii.–xxiii., 1887.
[2] *Cf.* Am. Nat., xxi. p. 294, 1887.

cavity; nor do his statements seem conclusive that they give rise to the blood-corpuscles and the fat-bodies. The fact that the cells which he finds in the pericardium may originate from the entoderm and may form blood-corpuscles is not so doubtful. From the somatopleure he derives (1) all the muscles of the body except those of the mid-gut *si elle existe;* (2) the aponeurotic layer of the cephalothorax; (3) the membranes of the fore and hind guts, of the tracheæ and glands, and of a portion of the genital ducts,—that is, of all organs derived from an ectodermal invagination; and (4) the sarcolemma and neurilemma. From the splanchnopleure are developed (1) the envelopes of the mid-gut, (2) the genital organs, (3) the pericardium and the pulmonary veins, while the dorsal mesentery gives rise to (1) the heart, (2) the lateral arteries, and (3) the suspensors of the heart.

As will be seen, Schimkewitsch accepts the idea of Bütschli, that the cavity of the heart corresponds to the segmentation cavity, and that its walls are derived from the two moities of the mesentery,—facts which explain the communication of this organ with the yelk. The splanchnic mesoderm encroaches upon the yelk, dividing it into lobes, which persist in the lobes of the liver. The epithelium of the mid-gut begins to form first behind, that of the liver being at first formed of two kinds of cells,—one representing the true hepatic, the other ferment, cells. At the time of hatching no genital openings are developed, but the genital glands bend downwards at their anterior extremities, and this decurved portion represents the mesodermic portion of the genital duct.

Of the ectodermal structures we need only to say that the account of the development of the eyes is at variance with the results of Locy, and then turn to the lungs and nervous system. Regarding the discussion of the former and their homologies with the branchiæ of Limulus, our author seems as much at sea as he did in his former paper[1] on the anatomy of Epeira. He says that at first the lung is a bunch of tracheæ, but his sole figure of the embryonic lung exactly parallels in its structure the early gill of Limulus. The early gill-book and lung-book (not the stigma, etc.) could have been drawn the one from the other without one's being able to detect the difference.

The first appearance of the ventral cord is by two thickenings near the median line, which from the first have a segmented character. Later, they become widely separated, as a result of the reversion of the embryo. The rudiments of the brain are at first distinct from each other, and from those of the ventral cord. The ganglia of the cephalothorax are cephalic, rostral, mandibular, and maxillary, one pair each, while the pedal ganglia number four pairs. His sections show the cephalic invaginations described by Balfour, but he gives no suggestions as to their fate

[1] Ann. Sci. Nat., VI., xvi., Art. I., pp. 67 and 84, 1884.

in the adult. The cephalic ganglia give rise to the optic nerves; the rostral ganglia, which occupy a place on the supero-lateral face of the supra-œsophageal ganglia, are compared with the labial ganglia described by Tichomiroff in Bombyx, while the mandibular ganglia, which also enter into the composition of the brain, give rise to the sympathetic nerve.

The speculations which conclude the article, as to the homologies of the nervous system in various Metazoa, are not equal to the rest of the paper.—*J. S. K.*

MICROSCOPY.[1]

Method of Staining and Fixing the Elements of Blood.[2]—Recent discoveries of morphological elements in the blood hitherto unknown, as well as the newly published facts concerning its coagulation, have aroused an interest in the subject which calls for an acquaintance with the methods with which it is possible to follow those results. Accordingly, I would like to describe the method employed in this laboratory; for, although it has been mentioned by Professor Gaule in his lectures for several years, it has not as yet been published.

The methods formerly used were that of examining fresh blood and that, perfected by Ehrlich, which consisted in staining dried blood.

Our method consists in a series of manipulations requiring only thirty-five minutes for their completion.

The following is a list of the reagents, together with the length of time and the order in which each is to be used:

		Min.
1.	Corrosive sublimate (concentrated solution)	6
2.	Distilled water	1
3.	Absolute alcohol	5
4.	Distilled water	1
5.	Hæmatoxylin (½ per cent. alum solution to which, for every 100 c.cm. employed, 20 drops 5 per cent. alcoholic solution have been added)	6
6.	Distilled water	1
7.	Nigrosin (½ per cent. water solution)	1
8.	Distilled water	½
9.	Eosin (1 gr. eosin dissolved in 60 c.cm. alcohol; 140 c.cm. distilled water)	2
10.	Alcohol	5
11.	Oil of cloves	1–2
12.	Xylol.	
13.	Canada balsam (diluted with xylol until it readily flows).	

As receptacles for these fluids, each person has upon his table

[1] Edited by C. O. WHITMAN, Milwaukee, Wisconsin.

[2] From the Physiological Laboratory at Zurich.

three shallow glass dishes with flat bottoms, so large that a slide may be easily put in and taken out of them. Into the first of these we pour corrosive sublimate, into the second distilled water, and into the third absolute alcohol. It is necessary either to label the dishes or to place the two not at the moment in use at one side. For the coloring fluids we use bottles whose stoppers serve at the same time as droppers or pipettes. The most convenient form has a glass stopper, which is hollow and drawn out into a fine point below, while above it broadens into a funnel with a lip whose opening is closed by a rubber membrane. A slight pressure upon the membrane causes, upon the removal of the finger, a rise of fluid in the funnel, which, upon the removal of the stopper from the bottle, can be at pleasure dropped upon the slide. For oil of cloves, xylol, and Canada balsam wide-mouthed bottles are used. In the first two bottles are brushes; in the last, the ordinary glass rod. Other necessary utensils are a glass rod, sharp-pointed scissors, clean slides and cover-slips, filter-paper, twine or coarse thread, a small bottle of absolute alcohol, a sharp, clean needle, a fine clean rag, and a hand-towel.

Aside from these, a board, fifteen by five inches, with two pair of holes, large enough for a piece of tape to pass through double, is an essential help. The first pair of holes should be four inches distant from the second, and the two holes of each pair one and a half inches apart. The tape should be so passed through the holes that there will remain upon one side of the board loops, on the other long ends, by which, upon passing the extremities of the frog through the loops, one may easily and firmly tie the frog upon the board. Such preparation is necessary, otherwise the manipulations cannot follow one another quickly enough. After these preliminaries have been completed, the labelled bottles being placed within reaching distance, the distilled water and alcohol in front of these, and the corrosive sublimate nearest of all, we are ready to bind our frog upon the above-mentioned board and begin our preparation. We make use of the frog for this purpose at first, since its blood coagulates less quickly than that of mammals. The vena femoralis, which may be seen as a dark blue line below the knee-joint on the inner side of the leg, having been snipped, we quickly bring with a glass rod a drop of the blood which comes from the wound upon a slide previously moistened by the breath, and throw the whole into the dish of sublimate for six minutes. If a little care is taken to spread out the drop of blood in putting it on the slide, the result is more satisfactory. Brought from the sublimate into the dish of water, we find that the greater part of the blood adheres to the slide. The superfluous sublimate being washed from the preparation during the moment that it remains in the water, we next partially dry the slide by resting it upon filter-paper before dropping it into the alcohol bath. The slide, which has remained in alcohol

six minutes, is brought again into distilled water for half a minute, since our coloring fluids are water solutions. The hæmatoxylin is then dropped upon the slide, and removed again at the end of six minutes by resting the edge of the slide upon filter-paper, and afterwards washing with distilled water for one minute. The same process follows with the nigrosin and eosin, the first remaining upon the slide for one minute, the second two minutes. From the eosin we bring the preparation directly into alcohol, since the eosin is partially an alcohol solution. At the end of five minutes the slide is taken out of the alcohol, and, in order to be quite sure that there is no water still clinging to the preparation, we incline the slide at a slight angle to the rag with which we are holding it, and pour a few drops of alcohol from the small bottle over it. If upon dropping oil of cloves on the preparation it should be dark upon a dark sleeve or other dark background, we may remove the oil of cloves with a few drops of xylol. Having quickly cleaned the slide close up to the preparation, we place a drop of Canada balsam upon it, which must be allowed to spread out before the cover-slip is lowered upon it.

Human blood is prepared in the same way, except that here the finger-tip undergoes the surgical operation. If a finger of the left hand be lightly bound with a string and a sharp needle be held in the right a quarter of an inch from the end, one quick energetic stroke suffices to bring a drop of blood to the surface, which should be transferred to the slide by drawing it, previously moistened, across the drop of blood.

A look at our preparations with the microscope shows us that the coloring substances we have used have attached themselves to certain parts and certain forms of corpuscles. In the preparation of the frog's blood we find that the large oval red corpuscles have been colored red with eosin. The nuclei are for the most part blue from hæmatoxylin, the well-known coloring substance for nuclei. The protoplasma, provided no coagulation has occurred, is homogeneous. The usually oval nuclei are also generally homogeneous, though occasionally granulated like the nuclei of other cells.

The white blood-corpuscles differ among themselves in form, color, and the number and size of their nuclei. 1. Those coarsely granulated which are deeply colored with eosin, hence their name "eosinophilous cells,"[1] are perhaps the most striking. Their form is usually round, and they contain from one to four nuclei. 2. A second kind is perhaps best characterized by its large nucleus sparely surrounded with protoplasma, colored blue with nigrosin. The form of the cell, according to the position in which we see it, is spindle-shaped, with an oval nucleus in which the granules

[1] This name was given by Ehrlich.

are distinct, and seem to be arranged in lines parallel to the long axis of the nucleus, or it is quite round with a round nucleus. The name "hæmatoblasts" was given them by Hayem. 3. Another variety has, like the "eosinophilous cells," several nuclei. Its protoplasma is, however, blue like that of the "hæmatoblasts," its form irregular, recalling the forms that the amœba is wont to assume; accordingly such cells have been called "amœbocytes." 4. Occasionally one sees still another cell, whose single large nucleus is oval or irregular in outline and lies in protoplasma like that of the "amœbocyte." These cells are larger than the other white blood-corpuscles, and contain here and there foreign bodies, such as pigment-granules and drops of fat in their protoplasma. They are called on account of their form "endotheloid cells." With further study of the preparation other forms are found, which may be looked upon as intermediate between "hæmatoblasts" and "amœbocytes," for in some cases the corpuscles have nuclei like "hæmatoblasts," whereas the protoplasm has increased in amount and sent out projections like the pseudopodia of an amœba; in others the nucleus is round instead of oval; in others still the nucleus seems to be in the act of falling into two parts.

These latter forms suggest the idea that a relation may exist between "amœbocytes" and "hæmatoblasts," but what the relation may be, whether the change is from "amœbocyte" to "hæmatoblast" or the opposite, whether the "eosinophilous cells" and "endotheloid cells" are in any way related to them and to one another, cannot be determined by the method just described. Two courses lie open to us in our attempt to answer these questions: 1, to examine the same blood at intervals after it has been taken from the frog; or, 2, to watch changes in fresh blood which has been protected from evaporation. To do the first, we have simply to place a slide with a drop of blood upon it in a moist chamber,[1] and after certain intervals (five minutes, fifteen minutes, half an hour, two hours) to fix and color the blood as above. If we examine a preparation fixed at the end of two hours, the whole aspect is changed. We find representatives of the different forms, but not in the same proportion. The "endotheloid cells" have become more numerous and the other forms less so. The former have also become much larger, with broad hyaline borders. The granules of the protoplasma are coarser about the nucleus, but constantly smaller and less distinct towards the hyaline border. Between the protoplasma-granules are frequently pigment-crystals and bodies colored with eosin. These foreign bodies lie often in clear oval spaces next to the nucleus; otherwise these spaces are empty, or

[1] The moist chamber is easily constructed by covering the bottom of a flat-bottomed dish with wet filter-paper and placing a ground-edged cover upon the dish, whose edges should also be ground.

contain a small nucleus, a clump of yellow pigment, or a body closely resembling a small red blood-corpuscle. To control this experiment we may make use of another one,—that is, we may cover a fresh drop of blood with a cover-slip and seal it from the air.[1] Thus the blood coagulates slowly, and we may study directly the changes the forms undergo during coagulation. The granules of the "eosinophilous cells" may be seen to become larger, less distinct, and disappear. The "eosinophilous cell" has developed into the "amœbocyte." The "hæmatoblasts" assume the forms mentioned above, the nucleus and cell as a whole become round, and at length send out pseudopodia in every direction, so that it is impossible to distinguish them from "amœbocytes." The "amœbocytes," in their turn, at first stretch out their pseudopodia in a lively manner, then gradually attach themselves to the cover-slip, where they spread themselves over a large surface, and resemble the "endotheloid cells" with their broad borders of hyaline substance and the granulated protoplasma about the nucleus. If we now bring together the facts we have observed,—1, in instantly fixed blood; 2, in blood fixed after intervals; 3, in fresh blood,—we find that the first three kinds of white blood-corpuscles may at length become "endotheloid cells."

What is, then, the fate of the "endotheloid cells"? Are the bodies we have described as lying in their protoplasma and resembling incomplete blood-corpuscles to be considered as such? The endothelial cells which they resemble are, as is known, broad, flat cells that lie spread out on the inner surface of the blood-vessels similarly as the "endotheloid cells" flatten themselves out on the cover-slip. Their protoplasma is colored with nigrosin, and in the small capillaries, where one or two cells suffice to form the circumference of the capillary, has been observed to contain pigment and more or less developed red blood-corpuscles. Especially is this the case in the liver and spleen of the frog. If the spleen be teased out, and its cells fixed and colored in the manner mentioned above, not only do we find that the number of white blood-corpuscles, especially of the "endotheloid cells," is much larger in proportion to the red blood-corpuscles than it is in circulating blood, but other cells are present which possess the general characteristics of "endotheloid cells" and endothelial cells. They are richer in pigment, contain often several undeveloped red corpuscles, and cling together in groups. Gaule, in his Strassburg lecture, called these cells "ammenzellen," because in them he observed the development of the red blood-corpuscles. In the course of his observations of a series of frogs he noticed that the "ammenzel-

[1] The edges of the cover-slip must be thoroughly free from moisture, a bit of melted wax dropped upon every corner, and the wax then drawn along the edges of the cover-slip with a heated iron wire.

len" which lie in groups similar to the follicles of the animal spleen, between the arteries entering and the veins leaving the spleen on the periphery, undergo significant changes, normally, in the course of the winter, under the influence of pilocarpine, in a few hours. The result in both cases was the same. The "ammenzellen," at first rich in pigment, lose their pigment as the number of undeveloped corpuscles increases. At the same time the number of corpuscles in the circulating blood was counted, the result showing that as the pigment of the "ammenzellen" decreased the number of the circulating red corpuscles became greater, the quantity of undeveloped corpuscles increased, and that many of the circulating corpuscles were still bordered with granules of pigment. Another indication that blood-building elements are present in the "ammenzellen" was the iron reaction which the protoplasma gave with potassium ferrocyanide. From these observations it seems hardly to be doubted that red blood-corpuscles are developed in the "ammenzellen," and partially at least in the endothelial cells, and in the "endotheloid cells." The relation in which these three cells stand to the blood-vessels remains to be considered. The blood-vessels of the embryo have their origin, as the embryologists have taught us, in the mesoderm in chains of endothelial cells which contain clear spaces in their protoplasma that later communicate with one another to form a fine capillary, in whose walls the first red blood-corpuscles are formed. Returning to the spleen, we recall the fact that the "ammenzellen" groups lie between the capillaries of the arteries, with their endothelial cells on the one hand and the capillaries of the veins on the other hand, and that between the in-flowing and out-flowing vessels the regular blood-vessels with their lining cells fail. It is, then, not difficult to suppose that the "ammenzellen" and the "endotheloid cells," which are so numerous in the spleen, might be the stage upon which, as in the mesoderm of the embryo, a constant building of new blood-vessels and blood-corpuscles is taking place. The white blood-corpuscles of the frog may perhaps be looked upon as undeveloped "ammenzellen," though their origin and the functions peculiar to each form are not yet clear. It is significant that a seeming relation exists between the coagulation of the blood and the formation of white blood-corpuscles, for as the blood of the frog begins to coagulate the "hæmatoblasts" become especially numerous and group themselves characteristically; but to this point we shall refer again in connection with human blood, which is in many points similar to the blood of the frog.

The red blood-corpuscles of human blood contain, as is known, no nuclei. In our preparation they retain the disk form and color, like the protoplasma of the red corpuscles of the frog with eosin. The white blood-corpuscles are represented by the two forms "eosinophilous cells" and "amœbocytes." The "hæmatoblasts,"

as such, are wanting in human blood, but since we have had our attention directed by Hayem to the fact that the "hæmatoblasts" play an important part in the coagulation of the frog's blood, it is possible to think that some element is present in mammalian blood which also acts as a factor in coagulation. The coagulation of the frog's blood begins with the grouping of the "hæmatoblasts" into a rosette form. The red corpuscles then arrange themselves radially about this point as a centre. Do we find an analogous process at the commencement of the coagulation of mammalian blood? The blood of mammals coagulates very rapidly, whereas that of the frog changes very slowly; hence, if we would study the blood of mammals before coagulation, we must prevent this process by means of some reagent. Such an experiment cannot be tried with a human being, but is easily made with a dog. The reagent usually employed is peptone, which is injected in solution into the jugular vein of the dog, the amount injected being 0.3 grain peptone for every kilogramme weight of the dog. The microscopical examination of blood in which coagulation has thus been prevented shows that there exist in the blood, aside from the other elements, tiny tablet-like granules which tend to cling together in clumps. These elements were described by Bizozerro, and called by him "blutplättchen." It thus seems probable that the "blutplättchen" have something to do with the coagulation of the blood. That they also exist in human blood is evident from their presence in our preparation as small, faintly-tinged bodies, which lie in groups of twos and threes together. They did not disappear from the blood we employed, because we did not give it time to coagulate before fixing it. Therein lies the advantage of this method in the examination of human blood. It gives us not only the possibility to distinguish the different elements of the blood, but through it, it has been possible to discover elements which, like the "hæmatoblasts," accompany the phenomenon of coagulation, and also to determine in part the relation that exists between the elements. It would not agree with the general plan of nature if every form did not play a different rôle in the organism, and after all that has been discovered it is not improbable that we shall one day be able, through watching the changes which the different elements undergo in the blood, to discover the disturbances caused by different ferments and organisms in the blood. Thus we think that the hope of clever physicians may one day be verified, that the analysis of a drop of blood may give a clue to the pathological changes in the body.—*Alice Leonard Gaule.*

PSYCHOLOGY.

Intelligence of Echinoderms.—The experiments of Professor Preyer upon starfish and ophiurids tend to prove that they are

not entirely devoid of intelligence. In one series of experiments a piece of tubing was placed over one of the rays of a brittle star, so as to enclose it from its base nearly to its apex. Different individuals adopted different modes of ridding themselves of the tube, and one failing, would try another. Sometimes they rubbed the tube off by friction on the ground; if this was useless, they would hold down the tube with the other rays while drawing the imprisoned ray through it, or they would push the tube off with the serrated edges of the two adjoining rays, or, as a last resource, would cast off the imprisoned arm.

SCIENTIFIC NEWS.

—The meeting of the German Naturalists' Association will be held this year at Wiesbaden, from the 18th to the 24th of September. Herr Dreyfuss, 44 Frankfurter-strasse, Wiesbaden, is the secretary of the local committee.

—The San Diego Natural History Society have had a present of a valuable lot of land, and propose soon to erect a building.

—Dr. R. W. Shufeldt criticises—and deservedly so—the veterinary service of the United States army. He would elevate it by placing it on much the same basis as the regular medical corps.

—John Sang, a British entomologist of note, died March 2, 1887, of valvular disease of the heart, at the age of fifty-nine. He was especially interested in the moths, and was a zoological artist of no mean powers.

—Dr. J. S. Poljakow, the Siberian explorer and conservator of the Zoological Museum of the University of St. Petersburg, died in that city April 17, 1887.

—The late Miss Lucretia Crocker, of the school board of Boston, was influential in the support of the Annisquam laboratory from the year of its foundation, as well as an earnest advocate of the teaching of the biological sciences in the public schools. It is now proposed to raise two "Lucretia Crocker scholarships" in connection with the new Marine Laboratory, to be occupied each season by two teachers of the Boston public schools. Twenty-five hundred dollars are necessary for the purpose.

—Princeton College is to have a new biological laboratory in the early future.

—The new building for the Zoological Museum at Berlin is completed, excepting the internal finishing. This, it is estimated, will take until April 1, 1888, and then the collections will be

transposed from their present location in the university building to their future home. On the 1st of May of this year Karl Möbius, formerly ordinary professor of zoology in Kiel, entered upon the duties of director of the Berlin Museum, being thus associated with Professor Dr. Edouard von Martens.

—Johns Hopkins University is to publish, as a memorial volume, the researches of the late Dr. Adam T. Bruce on the Embryology of Insects.

—Armauer Hansen calls attention to a peculiar kind of whale-fishing which has been practised for a long time in the neighborhood of Bergen, Norway. Each year the fishermen take a couple of specimens of the small whale known as *Balænoptera rostrata.* Their implements are the most primitive harpoons, and it would hardly seem as if the insignificant wound they cause could prove serious. In from twenty-four to thirty-six hours the whale shows signs of weakness, and then is readily despatched. It is now found that the region of the first wound is gangrened, and that the weakness was in reality the result of blood-poisoning. All the fishermen now smear their harpoons with the gangrened flesh, and put them away to dry for use another year. M. Gade has carried on some culture experiments with the microbes obtained from the whales for three successive years, and finds each time the same bacteria, principally the same micrococcus. It is a curious fact, as Hansen remarks, that this peculiar use of bacteria and septicæmia should have been known for hundreds of years.

—*Science* has canonized one of the living African explorers. On a map of the African continent given in the issue of May 27 appears "St. Stanley's Falls."

—Professor Prestwich, who for thirteen years has held the chair of geology at Oxford, England, has resigned.

—Dr. Eugene Korschelt, formerly privatdocent and assistant in the Zoological Museum at Freiburg, Bavaria, has taken a similar place at Berlin, while his former position is now occupied by Dr. E. Ziegler.

—The professorship of zoology in the Zoological Institute at Kiel will not be filled until Easter, 1888. Dr. Karl Brandt, privatdocent in Königsberg, has been appointed the interim director.

—Bronn's valuable "Klassen und Ordnungen des Thierreichs" drags its slow length along. The last parts published are Nos. 56 of the Reptiles, by C. K. Hoffmann; 16 and 17 of the Birds, by Hans Gadow; and 29 of the Mammals, by W. Leche.

—Dr. J. S. Kingsley, the junior editor of this magazine, has accepted the professorship of biology in Indiana University. After September 1 his address will be Bloomington, Indiana.

—Professor J. C. Branner, of Indiana University, has been appointed director of the geological survey of Arkansas, with headquarters at Little Rock. The university has granted him a two years' leave of absence.

—The trustees of the Elizabeth Thompson fund have awarded the following sums for the advancement of science: The Natural History Society of Montreal, two hundred dollars, for the investigation of underground temperatures under the direction of a committee of the society; Drs. T. Elsler and H. Geitel, of the Gymnasium of Wolfenbüttel, Germany, two hundred and ten dollars, for researches on the electrization of gases by glowing bodies; Professor E. D. Cope, of Philadelphia, five hundred dollars, for the employment of a preparateur in connection with his researches on fossil vertebrates; E. E. Prince, of St. Andrew's, Scotland, one hundred and twenty-five dollars, for studies on the morphology and development of the limbs of teleosts.

—Recent Deaths.—Dr. François P. L. Pollen, a Malagassy explorer, in Leiden, May 7, 1886, aged forty-four; Arthur Edward Knox, an ornithologist, in Dale Park, England, September 23, 1886; Dr. G. A. Fischer, African traveller and ornithologist, in Berlin, November 11, 1886; Dr. William Traill, conchologist, in St. Andrew's, Scotland, December, 1886; Dr. John M. Wheaton, professor of anatomy and ornithologist, in Columbus, Ohio, January 28, 1887; Robert Gray, ornithologist and vice-president of the Royal Society of Edinburgh, in that city, February 18, 1887; Dr. Nathaniel Lieberkuhn, professor of anatomy and student of invertebrates, at Marburg, April 14, 1887, in his sixty-fifth year.

—Death of Professor William Ashburner.—Professor Ashburner, mining engineer and geologist, died in San Francisco, April 20, at the age of fifty-six. He studied for his profession at the Lawrence Scientific School of Harvard University, and afterwards at the École des Mines, Paris. Returning to this country in 1854, he visited the mineral region of Lake Superior with the late Professor Rivot, for the purpose of investigating the geology and mineral veins of said country, and subsequently explored a part of the island of Newfoundland, and in 1860 went to California as one of the staff of the geological survey of which Professor J. D. Whitney was director. In pursuance of his profession he travelled extensively through the mining districts of the United States, British Columbia, Mexico, and portions of Asia. He was one of the State commissioners of the Yosemite Valley and the Mariposa Big-Tree Grove from 1864 till 1880, and professor of mining in the University of California, having been appointed in 1874. In 1880 he was made a regent of the university, and was named by the late James Lick as one of the trustees of the California School of Mechanical Arts (one of Mr. Lick's bequests), and was also selected by Mr. Stanford as one

of the trustees of the Leland Stanford, Jr., University. Professor Ashburner was identified with all the principal organizations whose object is the intellectual development of the Pacific coast, —the microscopical, geographical, and historical societies,—and for many years he was especially active as one of the trustees of the California Academy of Sciences. In the directions above indicated he was an eminently useful citizen, and his personal bearing and qualities greatly endeared him to many. The death of such a man is a public misfortune.—*R. E. C. S., Washington, D. C.*, May 10, 1887.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Philadelphia Academy of Natural Sciences.—February 1, 1887.—Dr. Leidy stated that the prevalent opinion that bed-bugs might be introduced by bats and swallows seemed improbable. The insect found on the swallow is related to, yet different from, that which infests houses. On a couple of little bats from Panama Bay he had found an allied, yet different, insect, described by Westwood as *Polyctenes fumarius.* Professor Heilprin stated that the rhizopods identified by Miss Fielde at Swatow as identical with Philadelphia forms were *Difflugia* (two species) and *Arcella vulgaris.* Dr. Koenig gave the analysis of two forms of asbestos from Franklin, N. J., which are distinguished from Sussexite by the absence of the green flame under the blow-pipe.

February 15.—Professor Ryder spoke of the distribution of papillæ giving rise to sensitive or tactile hairs. Such hairs are usually divided into groups, one of which occurs near the eyebrows, one below the eye, and a third lower down. The gray whale of the Pacific coast had more of these tactile hairs than any other cetacean the fœtus of which he had examined. He had recently observed in an embryo kitten an orderly linear arrangement of such hair-papillæ on the back, apparently corresponding to the color-stripes to be developed later. There were none on the limbs and sides. Dr. H. Allen said that he had noted that moles on the human face occupied the same positions as the sensitive hairs of the lower animals. Dr. Allen also stated that in the wombat the biceps muscle passes from the pelvis to the foot, receiving three other muscles before its insertion. He suggested a formula, consisting of the use of arrows in different positions, indicating origin, insertion, direction, etc., so as to save labor in recording details. Professor Heilprin put on record the stranding of a specimen of the Mediterranean Risso's grampus on the coast at Atlantic City. Professor Sharp suggested that the eyes of Onchidium were phosphorescent organs, similar to those he had before described as existing in

Pecten, especially since the snail has no locomotive powers which would enable it to escape from a foe seen by such eyes.

March 15.—A couple of copper coins, taken from the stomach of an ostrich which recently died in the Zoological Garden, were exhibited by Mr. E. A. Kelly. They formed part of a hard mass, which partly filled the gizzard. It was evident from the condition of the bolus that the muscular fibres of the stomach had not kept up such a spiral movement as is found in the crop of the pigeon or the stomach of the cow.

New York Academy of Sciences.—April 4, 1887.—Dr. Henry H. Rusby read some notes of recent travel on a journey from La Paz to Para through the Bolivian Andes and the Beni and Madeira Rivers.

April 18.—Dr. Alexis A. Julien read a paper on the transformations of iron disulphide, illustrating his points with specimens.

May 2.—Dr. Henry H. Rusby read a paper in continuation of that of April 4, on his travels across South America.

May 9.—Mr. George F. Kunz presented a paper on jade and jadite, and also read a description of the meteorite which fell March 27, 1886, near Cabin Creek, Johnson County, Ark.

Biological Society of Washington.—April 16, 1887.—Dr. William H. Dall presented some notes on a recent exploring trip to Florida. Dr. H. G. Beyer spoke of the action of caffeine upon the kidneys. Dr. C. H. Merriam referred to the depredations of the bobolink, or rice-bird, in the rice-fields of the South. Mr. F. A. Lucas presented some notes on the os prominens in birds.

Middlesex Institute.—May 11, 1887.—Mr. Sylvester Baxter read a paper descriptive of his second visit to Zuñi, describing one of the dances. Mr. Clarence Pullen made some remarks upon the various Pueblo Indians.

Essex Institute.—May 16, 1887.—Annual meeting. The following officers were elected: President, Henry Wheatland; Vice-Presidents, A. C. Goodell, Jr., F. W. Putnam, D. B. Hagar, and Robert S. Rantoul; Secretary, George M. Whipple; Treasurer, George D. Phippen; Librarian, William P. Upham. The annual reports which were read show a very substantial prosperity on the part of this institution. The ordinary income was five thousand two hundred and five dollars and eighteen cents, while two bequests amounted to fourteen thousand dollars. The total property in funds and real estate amount to (at original values) over seventy thousand dollars. The additions to the library for the year amounted to twenty thousand seven hundred and thirty-nine volumes and pamphlets, and the library is now estimated to contain fifty thousand volumes and over two hundred thousand parts of volumes and pamphlets. The Institute exchanges with over two hundred kindred societies, over half of which are foreign.